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INFLUENCE OF PRECOOLING AND POTTING TREATMENTS ON ACE LILIES

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Today's consumer is a discriminating person who desires a quality product at a competitive price The potted Easter lily is an excellent example of such a product. For most purposes, desirable plants should have a maximum height of 18 to 20 inches (45 to 50 cm.) above the pot rim, a good flower count, full plant base, strong plant appearance, and healthy foliage color. The commercial grower must be interested in producing such plants in the shortest possible time to minimize production costs.

Clones of Lilium longiflorum are grown in the Pacific Northwest. Bulb harvesting time varies with weather conditions, and is usually in late September or early October. After grading, bulbs are usually shipped to cold storage facilities throughout the country for precooling (vernalization). Vernalization is necessary to shorten the forcing time required in the greenhouse, making Easter bloom possible. For many years, 4 to 6 weeks at $33^{\circ} - 35^{\circ}$ F was the generally accepted recommendation for precooling Easter lily bulbs. Such low temperature treatment also resulted in low flower count and short, sparse foliage at the base of the plant, especially with extended treatments.

Pot plant producers on the west coast follow a different procedure. Their potted nonprecooled bulbs are kept in the cold frame until forcing. Blaney et al. (1) reported that plants handled in this manner produced more flowers and had dense attractive foliage on the lower portion of the stem. Reiss (4) reported good results in Minnesota when nonprecooled bulbs were potted in October and stored in a block warehouse at a 40° to 50° F. night temperature for 30 days. The pots were then moved into a greenhouse maintained at a night temperature of 50° until forcing was begun. Merritt (2) reported that holding potted bulbs at 33° was not as advantageous as holding them in a cold greenhouse (similar to a cold frame).

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Smith (5) concluded from his work that low temperatures vernalized and high temperatures devernalized lily bulbs. Miller and Kiplinger (3) reported that when bulbs were exposed to periods of alternating temperatures, the time of flowering was controlled by the last temperature to which the bulbs were exposed. They also found that devernalization at 70° F. followed by vernalization resulted in lilies similar to those produced by the cold frame method.

Blaney et al. (1) stated that bulbs preheated at 70° to 80° F. for 14 to 21 days initiated a minimum of $l\frac{1}{2}$ more flowers per plant than did those exposed to precooling only. In addition, preheating produced plants with long, full basal leaves. Miller and Kiplinger (3) feel that the superiority of the cold frame method may be attributed to the "retarding" effects of the relatively high temperatures early in the season followed by a minimum period of vernalizing temperatures prior to forcing.

Studies were conducted in 1963 and 1964 to determine the effects of (1) precooling bulbs in the packing case versus precooling planted bulbs, (2) various precooling temperature treatments including some which simulate cold frame conditions, and (3) repotting in the middle of the forcing period, an old time procedure which supposedly improves the quality of the finished product.

1963 Study

Nonprecooled Ace lily bulbs $6\frac{1}{2}$ - 7 inches in diameter were used. The bulbs, which were from two sources, (A and B), were received on November 6 and 9, 1962, respectively. -- They were kept in the unopened packing cases at 70°F. until-November 15. On this date, the bulbs were sorted and grouped for the treatments listed in Table 1. Bulbs in treatments that required precooling in the packing cases were repacked in the original peat moss. Bulbs in treatments that required precooling in the pots were soaked for 30 minutes in a parathion, ferbam, PCNB solution and planted in 6-inch clay pans. The potting soil was a mixture of equal parts of composted soil, muck, peat moss, and sand. Pots and soil were stem-sterilized. Bulbs were planted midway from top to bottom in the pan. Bulbs precooled in the cases were handled in the same manner at the end of the precooling period and potted on December 19, 1962. Constant temperatures of 35° , 45° , and 50° were provided in cold rooms. The 32° -50° fluctuating temperatures were provided in a cool greenhouse. Heat was provided only to keep the temperature from dropping below 32°F. Shaded pots in treatment 3P were in the same greenhouse, but were covered with four layers of black shading cloth on a framework approximately 12 inches above the pots. The cloth was open on each end to permit air circulation, thus simulating a dark tunnel.

All plants were maintained at a 60° F. night temperature in the greenhouse starting on December 19. Each treatment consisted of three replicates of four plants from each bulb source, making a total of 2^4 plants per treatment. Plants were properly spaced as growth progressed. All plants were fertilized regularly with a mixture of one part ammonium sulfate and four parts sodium nitrate at 1 ounce per 2 gallons of water. Emergence of the growing tip from the soil was a few days earlier for the early potted bulbs but was relatively uniform in other respects.

Treatment			Days to first bloom ²		Plant height ³ (cm.)		Leaves per		Plant diameter ⁴ (cm.)		Flowers per plant		Shape of plant base ⁵	
	Bulb source	A	В	A	В	A	В	A	B	A	B	A	В	
l lP	Precooled in case 5 wks. 35°F. Precooled in pot 5 wks. 35°F.	132 127	133 130	34.5 40.0	35.8 39.8	77 77	75 76	77 77	75 76	4.1 5.1	4.0 3.8	3.3 3.8	2.4 2.6	
2 2P	Precooled in case 5 wks. 32-50 [°] Precooled in pot 5 wks. 32-50 [°]	137 137	140 139	36.2 37.1	34.0 33.6	89 92	80 87	89 92	80 87	3.1 5.0	3.3 3.9	3.7 4.7	4.2 4.2	
3P	Precooled in pot 5 wks. 32-50 ⁰ in dark	134	133	33.9	33.5	90	81	90	81	5.0	3.4	4.3	3.1	
4	Precooled in case 2 wks. 35°, 3 wks. 50°	1366		36.5		80		81		4.0		3.4		
4P	3 wks. 50°	127	130	38.8	36.7	88	77	88	77	5.5	4.1	4.9	3.8	
5 5 P	Precooled in case 2 wks. 50°, 3 wks. 35° Precooled in pot 2 wks. 50°.	139	142	35.6	35.1	89	84	89	84	4.3	3.2	4.1	3.3	
/-	3 wks. 35°	130	137	37.5	34.8	88	83	88	83	5.4	3.5	5.0	3.6	
6 6p	Precooled in case 5 wks. 50 ⁰ Precooled in pot 5 wks. 50 ⁰	141 129	141 130	38.0 35.5	36.5 38.5	91 92	88 89	91 92	88 89	4.1 5.1	3.9 3.8	3.6 4.6	4.1 3.6	
7	Precooled in case 5 wks. 32-35°, 4" pot, Feb. 1 6" pan	140	143	34.0	32.3	81	74	81	74	3.7	3.6	3.2	3.4	
7 P	Precooled in pot 5 wks. 32-35°, 4" pot, Feb. 1 6" pan	143	141	34.6	32.6	81	80	81	80	4.2	3.3	3.4	3.6	
8 8 p	Precooled in case 5 wks. 45° Precooled in pot 5 wks. 45°	316 127	136 128	38.9 40.1	35.0 36.2	94 90	85 81	94 90	85 81	4.7 5.1	3.7	4.6 3.8	3.6 3.2	

Table 1. 1963 Ace Easter lily potting and precooling treatments.¹

¹ Each figure represents the mean for 12 plants. ² From start of forcing to first open flower. ³ Height above pot rim (1 inch = approximately 2.5 cm.). ⁴ Diameter of the plant half way up the stem. ⁵ Rated from one to five with five representing a full attractive base. (based on leaf size and internode length). <u>6</u> Bulbs from the two sources accidently mixed together.

1963 Results

Results are presented in Table 1.

Precooling bulbs in the pot resulted in plants that bloomed 5 days earlier and produced 0.6 of a flower more per plant and a fuller plant appearance than did precooling bulbs in the case. Bulbs from source A produced plants that were 1.6 days earlier and 1.5 cm. taller, and had a higher leaf count and 0.9 more flowers than did plants from source B. Although plants from the two sources varied in the aforementioned aspects, their response to treatments was generally similar.

The shortest plants were developed from bulbs planted in 4-inch pots and then repotted in 6-inch pans on February 1. They were unsatisfactory, however, because they were slow to flower, had fewer flowers, and an open base.

Among the treatments where bulbs were potted prior to precooling, the best plants (if short plants are desired) were those precooled at a fluctuating $32^{\circ}-50^{\circ}$ F. in the light. They were relatively slow to bloom. Plants from bulbs precooled at 32° to 50° in the dark bloomed a week earlier than the others, but were similar in other respects and had a less full base. Precooling treatments of 45° for 5 weeks, 50° for 5 weeks, or 50° for 2 weeks followed by 35° for 3 weeks all produced quality plants. Plants vernalized at 45° and 50° had the highest flower count, but were also taller and less full in the base. Plants from bulbs precooled at a steady 35° or at 35° for 2 weeks followed by 3 weeks at 50° were the tallest, the earliest to bloom, and the least full at the base.

Among the treatments where bulbs were precooled in the case, differences in plant height were limited. The 35° F. precooling treatment resulted in earliest flowering but an open plant base. Precooling at 45° appeared best when all measurements were considered.

1964 Study

Bulbs were received from the same two sources, A and B, on October 28, 1964. Because of a misunderstanding, both lots of bulbs had been held in commercial cold storage facilities at 36° to 40° F. for 14 days prior to their receipt by the University. Therefore, all bulbs were kept at 70° F. in the unopened cases until November 12 (14 days). Bulbs scheduled for precooling in the pots were potted on November 12. Bulbs scheduled for precooling in the packing cases were potted on December 23. In all other respects, plants in the 1963 and 1964 studies were handled similarly. An extra 12 bulbs were potted on November 12 and placed directly in a 60° greenhouse. This group served as a check to determine whether the bulbs had been adequately vernalized prior to initiation of the experimental treatments.

Treatments and results are shown in Table 2.

Data on the 12 check plants are not presented as they were irregular in rate of development and plant quality. Only four plants bloomed by June 1, and plant diameter was two-thirds that of plants precooled after November 12. Plant height and bud count were close to normal. These results indicated that the bulbs had not been adequately vernalized prior to initiation of the experimental treatments.

Precooling bulbs in the pots was definitely preferable to precooling in the packing cases, because the plants produced by the first method were fuller, wider, and more attractive and had 0.75 more flowers per plant in 1 week less forcing time. Plant height was not significantly different. Plants from source A were 5 days later, 1 cm. taller, had a higher leaf count, and 0.7 fewer flowers per plant than plants from source B. Although the plants from the two sources varied as indicated, their response to treatments was similar.

Among the treatments where bulbs were precooled in the pot, the differences in flower number and fullness of plant base were small, differences in days to bloom were moderate, and differences in plant height were appreciable. The best overall plants (if short plants are desired) were those precooled for 2 weeks at 50° F. followed by 4 weeks at 35°, and those precooled for 2 weeks at 35° followed by 4 weeks at 50° Good quality, though tall, plants were provided by precooling at 35° and at 50°. Plants precooled at $32^{\circ}-50^{\circ}$ in the dark were also good but slower to bloom. The tallest plants were those vernalized at 45° , 50° , and $32^{\circ}-50^{\circ}$ in the light. The least satisfactory plants were those precooled for 2 weeks at 35° followed by 4 weeks at 40° .

Among the treatments where bulbs were precooled in the case, the 50° F treated plants appeared best. Precooling at 35° and at 35° for 2 weeks followed by 4 weeks at 50° also provided good quality plants. Highest bud count resulted from 2 weeks at 35° followed by 4 weeks at 40°. The poorest plants resulted from vernalization at $32^{\circ}-50^{\circ}$.

Discussion and Conclusions

Potted Easter lily producers agree that bulbs from different sources vary appreciably in their response to forcing. In addition, bulbs from the same source may be quite variable from year to year, as indicated in this study. For these reasons, bulbs from the same two sources were included in this study for 2 consecutive years. So, it was assumed, if any treatment gave consistent results throughout this study, the commercial grower should be able to get similar results from the application of that treatment.

Large bulbs, typical of those grown by most commercial producers, would have been preferable for such a study. A shortage of larger sizes for the 1963 and 1964 seasons necessitated using the $6\frac{1}{2}$ - 7 inch classification. Past experience has shown that large bulbs usually produce tall plants. Because almost all plants in this study were short, interpretation of height should be on a relative basis.

Treatment			Days to first bloom ²		Plant height ³ (cm.)		Leaves per plant		Plant diameter ⁴ (cm.)		Flowers per plant		Shape of plant base ⁵	
<u>. </u>	Bulb se	ource	A	В	A	В	A	В	A	В	A	В	A	В
l lP	Precooled in-case 6 wks. 3 Precooled in pot 6 wks. 3	5°F. 12 5°F. 11	25 1 18 1	21 12	41.1 41.3	38.0 41.0	93 85	81 77	93 85	81 77	3.8 5.3	4.9 5.0	4.4 3.6	4.7 4.7
2 2P	Precooled in case 6 wks. 32 Precooled in pot 6 wks. 32	2-50° 13 2-50° 13	33 1 23 1	.27 18	35.7 45.1	42.7 40.7	84 80	87 76	84 80	87 76	3.5 5.6	5.0 5.2	4.5 4.6	4.8 4.8
3P	Precooled in pot 5 wks. 32 in o	-50 ⁰ dark 12	24 1	13	38.2	42.3	79 ·	75	79	75	4.9	5.8	3.8	4.8
4	Precooled in case 2 wks. 3 4 wks	5°, s, 50° 12	27 1	18	4 <u>1</u> .4	39.2	87	75	87	75	4.6	4.6	4.6	4.6
4 P	Precooled in pot 2 wks. 3 4 wks	5°, s. 50° 12	21 1	16	39.8	37.7	79	72	79	72	4.8	5.8	4.8	4.6
5 5 P	Precooled in case 2 wks. 50 4 wks	0°, s ₀ 35° 12	27 1	.21	37.8	39.4	86	81	33	28	3.8	4.8	4.2	4.8
75	4	s 35° 12	21 1	14	36.2	37.1	72	77	28	30	4.3	5.9	4.5	4.7
6 6P	Precooled in case 6 wks. 50 Precooled in pot 6 wks. 50		25 1 22 1	.20 .15	34.9 45.2	41.8 40.0	77 79	89 73	26 30	28 39	4.2 5.5	5.1 5.3	4.4 4.3	4.3 4.4
7 7 P	Precooled in case 6 wks. 4 Precooled in pot 6 wks. 4	5° 12 5° 12	27 1 24 1	.28 .18	39.8 43.5	44.0 40.9	88 85	96 80	25 30	28 31	3.9 4.9	5.1 5.7	4.4 4.5	4.6 5.1
8 81	Precooled in case 2 wks. 3 4 wk	5°, 8.45° 1:	26 1	.30	46.0	39.5	85	80	28	28	4.0	5.4	4.6	4.4
<u> </u>	4 wk	s. 45° 1	21 1	.21	43.5	39.2	84	78	33	29	5.1	5.1	4.4	4.4

Table 2. 1964 Ace Easter lily potting and precooling treatments.¹

¹ Each figure represents the mean for 12 plants.
² From start of forcing to first open flower.
³ Height above pot rim (l inch = approximately 2.5 cm.).
⁴ Diameter of the plant half way up the stem.
⁵ Rated from one to five with five representing a full attractive base (based on leaf size and internode length).

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Results from both years for the two bulb sources indicated that precooling in pots was definitely preferable to precooling in packing cases. Plants precooled in pots flowered close to a week earlier, had better than 0.6 more flowers per plant, and were fuller and more attractive than those precooled in packing cases. Height was not significantly different. This finding is in agreement with the reports with the reports by Blaney et al. (1), Reiss (4), and Miller and Kiplinger (3). Therefore, this cultural procedure is recommended without reservation.

The treatment where bulbs were planted in 4-inch pots, then repotted in 6-inch pans was included in the study to determine whether a practice of many years ago would improve plant quality. Although plants in this treatment were the shortest in the whole study, they were not satisfactory as they produced fewer flowers, were slow to bloom, and had an open, unattractive plant base. Height was probably limited by two factors: (1) soil volume which limited available water and nutrients when plants were in 4-inch pots and (2) disturbance of the roots in repotting.

Interpretation of the value of various temperature treatments will vary with the needs of the individual grower and the size bulb he plants. The following plant groupings precooled in pots might be considered. The best overall plants resulted from precooling at 50° F. for 5 or 6 weeks, 2 weeks at 50° followed by 3 or 4 weeks at 35° and 5 or 6 weeks at a fluctuating $32^{\circ}-50^{\circ}$ in the dark. The tallest plants resulted from vernalization at a steady 35° , 45° , and 50° temperature and the shortest from 2 weeks at 35° followed by 3 or 4 weeks at 50° and fluctuating $32^{\circ}-50^{\circ}$ temperatures in the dark. Plants precooled at 35° forced in the shortest time, while those precooled at 45° were the slowest. Precooling at a fluctuating $32^{\circ}-50^{\circ}$ temperature, and at 50° for 2 weeks followed by 3 or 4 weeks at 50° . The lowest flower count followed precooling at 35° , 2 weeks at 50° followed by 3 or 4 weeks at 50° . The lowest flower count followed precooling at 35° , 2 weeks at 50° followed by 3 or 4 weeks at 35° for 6 weeks at a fluctuating 32° to 50° temperature in the dark

There was no consistent relation of leaf count to other factors measured.

Data for occasional plants with two shoots were not included in the averages.

Summary

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1. Ace lily bulbs from two sources were grown for 2 consecutive years.

2. The bulbs were precooled at various temperatures in the packing cases and after planting in the pots.

3. One group of bulbs was planted in 4-inch pots and repotted in 6-inch pans on February 1.

4. Precooling after planting in the pots resulted in earlier flowering, more flowers, and better plant shape than precooling in the packing cases.

5. The best overall plants resulted from precooling in pots at 50° F. for 5 or 6 weeks, at 50° for 2 weeks followed by a 35° temperature for 3 or 4 weeks, and a fluctuating 32° to 50° temperature in the dark.

6. Many of the temperature treatments provided satisfactory results.

7. Objectives of the individual grower should help determine which treatment he prefers.

8. Planting bulbs in 4-inch pots and repotting in 6-inch pans on February 1 was detrimental to plant quality.

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