Horticulture Mimeograph Series 302

March 1964

LILY DAY

WEDNESDAY, MARCH 4, 1964

Ohio Agricultural Experiment Station

Wooster, Ohio

Participating Staff

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PROGRAM

Research Review

10:00-12:30 A.M.	Tours of Research and Reviews of Exhibits
12:30-2:00 P.M.	Lunch. A box lunch in the Administration Building or at downtown restaurants.

Speaking Program

Robert O. Miller, Presiding

2:00 P.M.	Greetings	James M. Beattie, Assistant Director Ohio Agricultural Experiment Station
	The Urgency of Floricultural Research	Freeman S. Howlett, Chairman Department of Horticulture
2:30 P.M.	Past Ohio Lily Research	D. C. Kiplinger
3:00 P.M.	Present Direction of Ohio Lily Research	Robert O. Miller
3:30 P.M.	Physiological Studies with Lilies	Richard Payne
	Questions and Answers	

MUMS the word in June 1964

Don't forget the New York State Extension Service Chrysanthemum School, June 16-17, 1964 at the Gideon Putnam Hotel, Saratoga Springs, N.Y.

COMMENTS ON PAST RESEARCH IN OHIO ON LILIES

D. C. Kiplinger
Ohio Agricultural Experiment Station
Wooster, Ohio

Prior to the late 1940's much of the research on lilies consisted of evaluation of various types to determine their suitability for forcing and other types of investigations that have been superseded by more detailed studies.

Bulb Storage. In 1949, a report of an exhaustive study on the effect of cold storage on the forcing quality of Croft lilies was presented by Shoushan (11 and 12), and this is reproduced elsewhere in this publication. It was known then that at least 4 weeks of cooling were needed if the bulbs were to be forced most rapidly. It was also known that flowers formed most rapidly on bulbs stored at 50° F., second at 32° F., and last at 70° F. or higher. Prolonged cold storage was known to result in low bud count.

The results of Shoushan's work can be summarized by stating that the stem grows even when the bulb is in cold storage and growth is most rapid at 45° F., slower at 33° F., and still slower at 31° F. After storage for 5 weeks at either 31°, 33°, or 45° F., flower buds formed when the shoot was 3 inches above the nose of the bulb. Bulbs not exposed to cool temperature required 8 months to flower.

Leafscorch. On Croft lilies, a foliage disorder characterized by development of half-moon shaped, brownish-colored areas usually near but not at the tip of the foliage was causing a great deal of trouble in that it greatly reduced the sales value of the lily. Studies were undertaken to determine how best to prevent the trouble and these were reported by Stuart, Skou, and Kiplinger (13) and Stuart, Nelson, and Kiplinger (14). Both of these reports are reproduced in full elsewhere in this publication. Briefly they found that this disorder was most severely in acid soils when nitrogen was low. Additions of lime, limestone, or dolomitic limestone to raise the pH near the neutral point and regular use of nitrogenous fertilizer were effective in minimizing the difficulty, although the cause of the disorder was not discovered. (Editor's note - Furuta, Martin, and Perry reported in Proc. Amer. Soc. Hort. Sci. 83:803-807, 1963, that lily leafscorch is caused by lithium toxicity).

Temperature After Arrival Prior to Potting. The adverse effects of exposing bulbs to high temperatures from the time of their receipt to the date of potting has been reported by Lattimer (7), Kehl (5) and (3), and a brief discussion of these studies will be found elsewhere in this publication. Suffice it to say that exposure to temperatures of 90° F. for as little as 6 days could delay flowering by almost a week.

Reduction of Light Intensity During Forcing. Studies were made on the effect of reducing the intensity of light with cloth during forcing to simulate shade from adjoining buildings, trees, dirty or shaded glass, and the like, Lattimer (7) and (2). In all cases shading reduced the number of salable flowers by increasing the number of split or blasted flowers.

Storage of Finished Plants. A report by Newhart (9) showed that lily plants could be placed in dark refrigerators at 33° or 45° F. for 10 days without deleteriously affecting the keeping qualities of the flowers or plant if the buds were $3\frac{1}{2}$ to 5 inches long which is near or in the white "puffy" stage. Longer storage in the dark resulted in yellowing of the foliage.

Bulb Dips. Because root rot is a problem, particularly with Croft, an evaluation of various materials for a 30-minute soaking of the bulbs prior to potting was made together with planting in steam-sterilized and unsterilized soil (3). Root systems were examined just prior to flowering and there appeared to be no beneficial effect from soaking in Parathion, Fermate, Lysol, a combination of the 3 materials, Endrin, or Panodrench. The best root systems were found on plants in steam-sterilized soil. Since the roots grow away from any fungicide which adheres to the dormant bulb when applied as a dip or soak, it is not surprising that the fungicide would offer no protection from rot organisms. It would appear that drenches of fungicides might be useful if they could be applied to the area of the soil where the roots are most abundant.

Drying of Bulbs During Sorting and Grading. After digging, bulbs are sorted, graded, and then packed into cases for subsequent placing in refrigerated storage. During sorting and grading, the bulbs are exposed to the air which results in some loss of moisture. Dotts and Kiplinger (4) found 8-9 inch Croft bulbs exposed to the conditions in the grading shed for 1, 4, and 8 days prior to packing had 5.9, 5.3, and 4.3 salable flowers per plant when forced indicating that prolonged exposure was detrimental.

Comparative Development of Lilies. Lily forcers are well acquainted with the old rule of thumb that buds should be visible in the crown of the plant 6 weeks before Easter if the night temperature is 60° F. Experiments were run by Rider and Kiplinger (10) and Kiplinger, Miller, Jones, and Rider (6) to determine if an earlier stage of development could be found that would be easily recognized. Height of plants and number of leaves were found to be unreliable as a means of determining development. Although buds could be measured as early as 8 weeks before Easter (usually $\frac{1}{4}$ to 3/8 inch long), to do so resulted in injury to the leaves and flowers and it was deemed impractical.

Frame-Grown versus Pre-cooled Lilies. This is part of the current series of work. Reports have been made by Kiplinger, Miller, Jones, and Rider (6) and Miller, Kiplinger, and Snow (8) which will be found elsewhere in this publication.

Literature Cited

1. Anonymous. 1953. Temperature and light intensity during forcing on Croft lilies. Ohio Florists' Assn. Bull. 291:2.

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3. Anonymous. 1958. Tests on Croft lilies. Ohio Florists' Assn. Bull. 340:2-3.

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10. Rider, Dennis and D. C. Kiplinger. 1961. Comparative development of Ace and Nellie White lilies. Ohio Florists' Assn. Bull. 387:3-5.

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13. Stuart, N. W., William Skou, and D. C. Kiplinger. 1952. Further studies on causes and control of leaf scorch in Croft Easter lily. Proc. Amer. Soc. Hort. Sci. 60:434-438. Also in Ohio Florists' Assn. Bull. 268:2-3, and 10.

14. Stuart, N. W., K. S. Nelson, and D. C. Kiplinger. 1954. Fertilizer and lime affect amount of leaf scorch in Croft Easter lilies. Ohio Florists' Assn. Bull. 292:2-4.

LILY INVESTIGATIONS

by
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Though there has been considerable experimental work on the greenhouse forcing of Easter lilies, there is doubt in the minds of growers just what has been accomplished and shown to be true. This study was concerned with the effects of storage of Croft lilies in dry peat at 31°, 33°, and 45° F. on the initiation or formation of flower buds and their development.

What Has Been Found

Various phases of the problem of cold storage of Easter lilies have been studied at the Boyce Thompson Institute, Cornell University, and the U.S. Department of Agriculture, as well as by research workers in foreign countries. Some of the conclusions of this previous research are summarized below:

(1) After bulbs are dug, they may be forced into flower more rapidly if they are cooled for a period of time compared to bulbs which are not given the cooling treatment. This emphasizes the need for proper storage after digging to insure the most rapid development of the plant when it is forced.

(2) The cooling treatment must be at least of 4 weeks duration.

(3) The formation of flower buds occurs first in lily bulbs which were stored at 50° F., second on bulbs stored at 32° F., and last on bulbs stored at 70° to 85° F. This shows there is an optimum temperature for storage as far as speed of flower bud formation is concerned, but don't overlook the very important facts shown below in points No. 4 and 5.

(4) Storage at 45° to 50° F. is recommended only for bulbs that are to be flowered in January and February. This merely takes advantage of the speed of flower bud formation as affected by storage temperature—see No. 3.

(5) Prolonged cold storage results in a lower bud count. Bulbs stored at 45° to 50° F. "lost" bud count more rapidly than bulbs stored at 32° F.

Although the above "general truths" are quite well known to the trade, there are fundamental questions that remain unanswered, and it is evident that additional research is needed.

Some of these questions are as follows:

(1) *When are the flowers formed in the Easter Lily?*
(2) *How does cold storage of bulbs hasten flowering?*
(3) *Why does prolonged storage of bulbs reduce the number of flower buds?*

What We Did

In this study 8- to 9-inch single nose Croft lilies were received direct from the grower in Oregon through the courtesy of the Fight Floral Co., New York. The following is an outline of the treatments with 21 bulbs per plot:

I. *Stored at 31° F., dry peat on September 24, 1948.* On the first day of every month beginning in October, 1948, and continuing through June, 1949, 18 bulbs were removed from storage and placed in pots with the top, or "nose" of the bulbs 2 inches below the soil surface. The plants were grown at a day temperature of 60° F. and night temperature of 50° F. The remaining 3 bulbs from each plot each month were examined microscopically without being forced. From October through March, stem tips of the lilies were cut off when the length of the shoots were 3, 6, 10, and 14 inches above the nose of the bulb. From April through June these lengths were reduced to 2, 3, 4, and 5 inches because of evidence of more rapid development at this period. Six plants in each plot were allowed to flower.

The object of microscopic examination was to determine how and when the flower buds formed in these lily bulbs.

II. *Same as I except stored at 33° F.*

III. *Same as I except stored at 45° F.*

What Happened Within the Bulbs While in Cool Storage

The Easter lily bulb is usually referred to as a dormant structure, because the disc-shaped stem inside the bulb has not yet started to grow. This dormancy is brought to an end by processes which take place while the bulb is kept at a cool temperature. Carbohydrates are digested in the bulb scales and translocated or moved to the flat stem tip inside the bulb. If these processes can be hastened the length of dormant period will be shortened. This would mean that bulbs would sprout earlier.

We found that the starch granules which were stored in the leaves were digested at various rates in the three storage temperatures: they "disappeared" most rapidly at 45° F., more slowly at 33° F., and the slowest at 31° F. The bulbs might be all dormant at the three temperatures, but those stored at 45° F. were the closest to the end of their dormancy. They sprouted through the soil surface the earliest, followed by bulbs stored at 33° F., and the last to sprout were the bulbs stored at 31° F.

If the bulbs are left in storage until these changes are completed the stem will grow. It is not possible to know when the stem tip starts to grow unless it is sectioned and studied under the microscope. By doing that we found that the stem tip started to grow inside the bulb on March 1 when stored at 45° F., April 1 when stored at 33° F., and May 1 when stored at 31° F. The temperature of storage affected the rate of growth. Bulbs left one year in storage at 45° F. had stem tips about one-half inch above the base of the bulbs but in a few cases the stem sprouted through the nose of the bulb. On the other hand, bulbs stored at 33° F. and 31° F. had the stem tips still at the base of the bulbs, that is, no growth in length of stem took place while in storage.

What Happened in Forced Bulbs

It has just been shown that bulbs taken from different storage temperatures are in different stages of growth. On March 1 the bulbs started to grow in storage at 45° F., whereas they were still dormant at 33° and 31° F. The bulbs stored at 33° F. were closer to the end of dormancy than the bulbs at 31° F. When we potted these bulbs, those from 45° F. storage kept on growing and sprouted through the soil surface the earliest. The bulbs which were stored at 33° F. remained dormant in the pot for some time then started to grow, resulting in later sprouting through the soil surface. The bulbs stored at 31° F., then potted, remained dormant in the pots for an even longer period of time. The result was that they sprouted through the soil surface later than bulbs from the higher temperatures. This explains the difference in rate of sprouting through the soil surface as affected by cold storage temperature.

Table 1. The effect of storage at various temperatures on the average number of days from potting until sprouting. Bulbs placed in storage September 24, 1948.

Bulbs potted the first of	Storage Temperature		
	31-32° F.	33-35° F.	45-50° F.
October, 1948	42.0	46.3	44.0
November, 1948	37.7	36.8	34.4
December, 1948	29.0	29.7	25.2
January,1949	28.5	26.4	23.0
February, 1949	24.1	23.2	21.8
March, 1949	26.6	23.9	20.9
April, 1949	26.1	22.9	20.0
May, 1949	26.3	20.4	21.5
June, 1949	30.9	20.5	20.2

It should be noted that the time required for sprouting decreased markedly until February 1 whether at 45° F., 33° F., or 31° F. This is due to more growth of the stem within the bulb while in storage. Actually the bulbs were not always dormant when they were removed from storage for forcing.

In table 2 the average number of days from potting until maturity is shown for every storage treatment.

Table 2. The effect of storage at various temperatures on the average number of days from potting until maturity. Bulbs placed in storage September 24, 1948.

Bulbs potted the first of	Storage Temperature		
	31-32° F.	33-35° F.	45-50° F.
October, 1948	190.0	196.5	198.4
November, 1948	158.8	158.7	153.5
December, 1948	139.7	142.6	129.5
January,1949	134.4	122.0	114.7
February, 1949	110.7	108.7	101.8
March, 1949	96.8	100.3	88.9
April, 1949	88.1	85.2	79.9
May, 1949	89.0	81.4	75.8
June, 1949	88.6	75.9	73.4

This table shows that the effect of cold storage upon the flowering date of forced plants was similar to its effect upon sprouting; bulbs stored at 45° F. flowered the earliest, followed by bulbs stored at 33° F. Storage at 31° F. resulted in the latest flowering. It was also noted that the longer the bulbs were stored at any of the three temperatures the more rapidly did they come to maturity (took less time). This suggests that earliness of flowering obtained by storage at 45° F. might be a result of earliness of growth of stem within the bulb when its dormancy was ended. This was further proved by microscopic investigation described below.

The bulbs that were stored for one week at 31°, 33°, and 45° F. potted, and forced beginning October 1, had flower buds formed when the stem tip was 6 inches above the nose of the bulb. But with bulbs stored for five weeks, potted, and forced beginning November 1, flower bud formation took place when the stem tip was 3 inches above the nose of the bulb. The flower buds were not visible to the eye on the stem tip but could be seen by sectioning and examining them under a microscope.

All bulbs were potted so their "noses" were 2 inches below the surface of the soil. This shows that flowers were initiated when the stem tip was 1 inch above the soil surface. Most of the leaves were formed while the stem was growing in the soil. If the lily plant had fifty leaves, they had to be formed before the stem tip was one inch above the soil surface. No more leaves are developed after flower bud formation has taken place.

The bulbs forced November 1 sprouted the earliest after 45° F. storage, and the stem tips grew to a height of 3 inches above the nose of bulbs more rapidly than bulbs from 33° F. storage. The latter reached that 3-inch stage earlier than bulbs from 31° F. This shows that the earliness of flowering as a result of storage at 45° F. was a consequence of early growth of the stem after removal from 45° F. storage compared with the two lower storage temperatures.

The length of the stem when flower buds were formed was determined by the amount of vegetative growth the stem made before flower formation. It has been mentioned previously that food stored in the bulb was the main source for that vegetative growth. Consequently, if the amount of the stored carbohydrates was reduced, the stem would be shorter when flowers were formed. This was found in the following cases:

(1) Bulbs stored at 45° F. until January 1, and thereafter, then potted and forced, had flower buds formed earlier than bulbs stored at 33° F., and these in turn developed flowers earlier than bulbs stored at 31° F. It is quite possible that the higher respiration rate of bulbs stored at 45° F. reduced the amount of carbohydrates remaining in the bulbs when they were potted. Consequently, the vegetative growth made by bulbs which were stored at 45° F. was less than that made by bulbs that were stored at 33° F. The same explanation would hold true for comparing 33° F. storage with 31° F. storage.

(2) Longer storage of bulbs resulted in earlier flower formation. When bulbs were stored until May 1 and June 1 flower bud formation took place when the stem tip was 2 inches above the nose of the bulb, that is, just sprouting through the soil surface. This was found in bulbs stored at 31°, 33°, and 45° F. It is possible that the longer the bulbs were kept in storage the more respiration took place before the bulbs were forced. The result would be less carbohydrates present in the bulbs, and less vegetative growth made by stem before flower formation occurred.

(3) Storage at 45° F. resulted in shorter plants compared with storage at 33° F. as shown in table 3.

Table 3. The effect of storage at various temperatures on the average length of stem at maturity. Bulbs placed in storage September 24, 1948.

Bulbs potted the first of	Storage Temperature		
	31-32° F.	33-35° F.	45-50° F.
October, 1948	29.6 inches	31.9 inches	30.0 inches
November, 1948	38.9 inches	40.5 inches	40.5 inches
December, 1948	32.9 inches	36.2 inches	38.8 inches
January,1949	27.7 inches	32.4 inches	29.1 inches
February, 1949	26.8 inches	30.2 inches	26.1 inches
March, 1949	29.1 inches	30.3 inches	28.7 inches
April, 1949	22.8 inches	26.6 inches	22.5 inches
May, 1949	22.0 inches	28.4 inches	26.2 inches
June, 1949	25.6 inches	23.5 inches	23.0 inches

The higher respiration rate at 45° F. might result in less carbohydrates available for growth of the stem. The amount of vegetative growth might be less after storage at 45° F., than after storage at 33° F. Later in the forcing period, more carbohydrates were synthesized in the growing leaves. But it was too late as the amount of vegetative growth was already determined before the stem tip was 1 inch above the soil surface.

(4) Bulbs stored at 31° F. showed drying of the outer scales due to low humidity in the storage box. When forced, such bulbs produced shorter plants than bulbs stored at 33° F. An explanation for this is that the carbohydrates stored in the scales must be digested by enzymes before they become available for growth of the stem. Dryness of the scales might reduce the enzymatic activity, and consequently reduce the amount of carbohydrates stored in these scales which is necessary for the growth of the stem. The result would be reduction of vegetative growth, and the plants would be shorter.

How Cold Storage Affected the Number of Flowers per Plant

The average number of flowers per plant is given for every storage treatment in Table 4.

Reduction of number of flowers was brought about in bulbs forced April 1, May 1, and June in two ways:

(1) The stem tip did not develop more flower buds after one or two flower buds were formed, and (2) the uppermost flower bud continued to grow, whereas the basal flower buds ceased to grow. This might be due to insufficient supply of carbohydrates in the bulbs for the growth of all the flower buds formed on the stem.

Table 4. The effect of storage at various temperatures on the average number of flowers per plant. Bulbs placed in storage September 24, 1948.

Bulbs potted the first of	Storage Temperature		
	31-32° F.	33-35° F.	45-50° F.
October, 1948	6.2	6.1	6.7
November, 1948	5.5	5.8	5.2
December, 1948	4.9	5.9	5.2
January, 1949	3.6	4.6	4.6
February, 1949	3.9	5.1	4.2
March, 1949	3.9	3.7	3.3
April, 1949	2.4	3.0	2.3
May, 1949	1.4	3.2	2.4
June, 1949	1.3	2.0	2.4

The data in table 4 show that plants from bulbs stored at 33° F. had more flowers than plants from bulbs stored at 45° F. Perhaps this was due to higher respiration resulting in less available carbohydrates in the 45° F. storage. In addition, table 4 shows that plants from bulbs stored at 33° F. had more flowers than plants from bulbs stored at 31° F. Undoubtedly this was due to the drying of the outer scales on bulbs stored at 31° F., and the resulting loss of stored food in these scales would reduce the bud count.

SUMMARY

1. While in storage the stem grows within the bulb. At 45° F. this growth is more rapid than at 33° F., and growth at 33° F. is more rapid than at 31° F.
2. After storage for 5 weeks at 31°, 33°, or 45° F., flower buds formed when the stem was 3 inches above the nose of the bulb.
3. The longer the bulbs are stored, the fewer the number of flowers that develop.
4. Unstored bulbs require about 8 months to mature.

FURTHER STUDIES ON CAUSES AND CONTROL OF LEAF SCORCH IN CROFT EASTER LILY

By

N. W. Stuart[1], William Skou[2], and D. C. Kiplinger

A leaf disorder of Croft Easter lilies, known as scorch and described previously (1, 4), appears to be increasing in importance in many sections of the country. The exact cause of this physiological disease is unknown but both cause and control seem to be related to the mineral nutrition of the plant. At the Plant Industry Station, Beltsville, Maryland, it has been observed for some years that additions of nitrogen during forcing result in the production of fewer scorched leaves than when no nitrogen is added. This finding has been confirmed by Seeley (3). More recently in a forcing test cooperative with the Oregon Agricultural Experiment Station, Corvallis, Oregon, bulbs which had been grown with 12 fertilizer treatments were found to respond differently when forced at Corvallis and Beltsville (1). At Beltsville, fewer scorched leaves were produced on the plants in 9 of the 12 treatments as a result of nitrogen applications during forcing. At Corvallis no field treatment tested tended to correct the tendency to scorch when the bulbs were forced. In the greenhouse when bulbs received fertilization corresponding to that applied in the field, only those given phosphorus plus potassium and sulfur treatment had significantly reduced amounts of scorch.

During the 1950-51 season Croft Easter lily bulbs assembled by F. P. McWhorter from twenty-one West Coast growers were forced at Corvallis, Ore., Columbus, Ohio, and Beltsville, Md. No supplemental fertilizer was applied during the forcing season. Results of this test (to be published in detail elsewhere) show that a great deal of variability existed among the various lots with respect to time of blooming, height of plants, and development of leaf scorch. The total number of scorched leaves on ten plants from each lot forced at Beltsville ranged from 37 to 195. The fact that these numbers were substantially larger than those on plants from the same sources that were forced at Columbus suggested that the soil, water, and forcing environments played roles in scorch development. A cooperative experiment to test this hypothesis, carried out by Ohio State University, Columbus, and the United States Department of Agriculture, Beltsville, Md., is reported in this paper, along with other experiments at Beltsville.

A case of two hundred 8- to 9-inch Croft Easter lily bulbs grown in Harbor, Oregon, and supplied through the courtesy of Harry Sharp, Seattle, Washington, was received at Beltsville on November 10, 1950 and stored dry at 35° F. The bulbs had been dug September 10 and held in common storage until October 4 when they were shipped in a refrigerated car to Detroit, Michigan where they were placed in storage at a temperature of 32° to 34° F. from October 20 until November 5. They were then shipped to Beltsville by ordinary express. On December 5, 100 of the bulbs taken at random from the case were potted in 6-inch pots containing 2/3 composted soil and 1/3 sand. They were placed in the greenhouse and grown with a night temperature of 60° F. except as noted. The remaining 100 bulbs were shipped to Columbus, where they were potted on December 11 in a mixture of 3 parts of soil and 1 part of manure by volume. The same fertilizer treatments were used at both locations (Table 1).

On the average a few more days were required for blooming at Columbus than at Beltsville. In most treatments the plants at Beltsville were slightly taller, but there was little difference in number of blooms per plant. The numbers of scorched leaves on the 10 plants in each treatment were recorded on February 20, March 13, and April 3. On the first date there were no scorched leaves on the plants at Columbus, while at Beltsville the greatest number was present on the unfertilized plants. Three weeks later there were still very few scorched leaves on the plants at Columbus but the average number per treatment at Beltsville was 103. By April 3 scorched leaves were present on plants in all of the treatments at Columbus with the greatest number occurring on the unfertilized plants. The average number per treatment, 32, was small in comparison with the corresponding number, 188, at Beltsville.

Of the regular water and fertilizer treatments numbers 6 and 10, involving the application of ammonium sulfate at the rate of 1 ounce per 2 gallons of water at 2-week intervals (6 applications) produced the least scorch at Columbus. The total numbers were well below those occurring on the unfertilized plants, and the result is in agreement with previously described earlier tests. These treatments with ammonium sulfate produced more scorch than the others at Beltsville, nearly three times as much as occurred on the unfertilized plants. Why did the treatments with similar bulbs produce opposite effects at the two locations? Apparently the answer is to be found in the differences in soil and water used. At Columbus the unfertilized soil had a pH value of 7.3 on March 28. Soil given treatments 6, 7, and 10 had pH values of 6.7, 7.6, and 7.0 respectively. The pH of the water used was 10.5. At Beltsville, on the other hand, the original soil mixture had a pH value of 5.8. By March 30 the applications of ammonium sulfate in treatment 6 had lowered it to 3.9 while the sodium nitrate (treatment 7) had raised it to 6.7. The tap water used had a pH value of 7.2 to 7.4.

At both locations when the bulbs were forced at 60° F., the fewest scorched leaves were produced on plants receiving regular applications of a complete fertilizer but underwatered. At Beltsville underwatered plants were watered only twice weekly while the overwatered ones (treatment 5) were watered daily. At Columbus the overwatered plants were watered daily while the underwatered ones were watered half as often as those watered normally. It seems probable that underwatering resulted in less leaching of nutrients. Underwatered plants had the lowest bud count at Beltsville and were also shorter than the plants given most other treatments. Forcing at 50° F. produced the shorter plants (usually they would be taller) but nearly four more weeks were required for blooming than when the plants were forced at 60° F. The Beltsville plants had the fewest scorched leaves following this treatment and it was effective at Columbus. Likewise, the application of dried blood at potting time as described by Seeley (3) was of some benefit.

The reasons why low pH seemed to be conducive to increased scorch were studied in several other tests at Beltsville. In one of these Oregon-grown Croft bulbs, 9 to 10

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inch in size. were potted in a very infertile soil having a pH value of 4.5. Other lots were potted in the same soil to which dried blood had been added at the rate of 3 grams per pot. For comparison, similar bulbs were potted in this last soil and also in composted soil-sand mixture to which ammonium sulfate was applied at the rate of 1 ounce per 2 gallons of water at 2-week intervals or a 4-12-4 complete fertilizer was added at the rate of one-half teaspoonful per pot also at 2-week intervals. Plants in the poor soil without fertilizer were only 16 to 17 inches tall at blooming time and had two blooms per plant and every leaf scorched. Addition of dried blood alone had little effect, but dried blood plus a complete fertilizer increased the average plant height to 22.4 inches and the blooms per plant to 3.4; nearly all the leaves showed some scorch, however. The corresponding plants in the composted soil with dried blood and complete fertilizer averaged 25.8 inches in height and had 4.8 blooms per plant but numerous leaves were scorched. These plants would have been salable, however, while those in the poor soil alone would not.

In another test of Oregon-grown 7- to 8-inch Croft bulbs from a case supplied through the courtesy of McHutchison & Co., New York City, were planted in glazed crocks containing quartz sand. They were watered twice weekly with a nutrient solution containing 98 ppm of nitrogen, 97 of potassium, 77 of phosphorus, 48 of magnesium, and 100 of calcium plus small amounts of the micro-nutrients. In addition, 27 or 81 ppm of aluminium or 11 ppm of manganese was added to certain lots since it was felt that these elements might have caused the scorch when the lilies were grown in poor soil. Nearly all the plants showed some scorched leaves and the numbers were not significantly greater in the lots receiving aluminum or manganese. The 81 ppm of aluminum dwarfed the growth of the plants. Calcium may have prevented more scorch development.

Other bulbs from the same lot were grown in glazed crocks containing quartz sand and watered with solutions of ammonium sulfate, ammonium nitrate, or calcium nitrate, each at the rate of 98 ppm of nitrogen alone or in combination with phosphorus, potassium, and magnesium at the rates used in the test just described. Calcium was added at the rate of 20 ppm to the solutions where nitrogen was supplied by the ammonium salts since it was known from previous tests that lily buds will blast in the absence of

(Continued on Page 10)

Table 1. Results of forcing 8-9 inch Oregon-grown Croft Easter lily bulbs potted December 5, 1950 at Beltsville, Maryland (Belt.), and December 11 at Columbus, Ohio (Col.)*

Fertilizer treatment	Frequency of watering	Forcing temperature	Average No. of days until first flower appeared		Average No. of flowers per plant		Average height of plant in inches		Cumulative number of scorched leaves on 10 plants on					
									Feb. 20		March 13		April 3	
			Belt.	Col.	Belt.	Col.	Belt.	Col.	Belt.	Col.	Belt.	Col.	Belt.	Col.
1. None applied.	As needed	60° F.	101	107	5.0	5.9	21.9	16.4	36	0	109	2	140	56
2. ½ tsp. of 4-12-4 per 6-inch pot every 2 weeks.	As needed	50° F.	132	145	4.7	4.2	15.3	12.3	1	0	13	0	52	7**
3. ½ tsp. of 4-12-4 per 6-inch pot every 2 weeks.	As needed	60° F.	106	109	5.4	5.5	20.4	17.1	28	0	125	1	226	33
4. ½ tsp. of 4-12-4 per 6-inch pot every 2 weeks.	Under-watered	60° F.	108	108	4.4	4.7	16.4	17.7	3	0	49	1	60	7
5. ½ tsp. of 4-12-4 per 6-inch pot every 2 weeks.	Over-watered	60° F.	107	110	5.2	5.2	18.7	17.1	1	0	56	8	149	51
6. Ammonium sulfate 1 oz. per 2 gal. every 2 weeks.	As needed	60° F.	106	112	4.6	5.3	20.5	17.8	5	0	129	0	403	17
7. Sodium nitrate 1 oz. per 2 gal. every 2 weeks.	As needed	60° F.	108	111	5.7	5.8	19.6	15.6	4	0	45	1	134	41
8. 3-inch pot dried blood per 3 bushels of soil at potting.	As needed	60° F.	106	107	5.3	5.7	22.7	16.8	20	0	77	0	106	42
9. 3-inch pot dried blood per 3 bushels of soil at potting plus ½ tsp. 4-12-4 per 6-inch pot every 2 weeks.	As needed	60° F.	105	111	5.5	5.5	21.0	16.5	19	0	127	4	193	56
10. 3-inch pot dried blood per 3 bushels of soil at potting plus ammonium sulfate 1 oz. per 2 gal. every 2 weeks.	As needed	60° F.	105	111	5.7	4.9	21.4	15.4	8	0	299	2	417	14
Average			108	113	5.2	5.3	19.8	16.3	12	0	103	2	188	32

*Prior to forcing bulbs were handled as indicated in text.
**37 on May 5.

calcium in the nutrient solution. In other treatments calcium carbonate was added to the sand when the bulbs were planted at rates of 5, 15, or 25 grams per crock. The best plants were produced when complete nutrient solutions containing calcium nitrate were used. Growth was poor when the ammonium salts were used alone. The least scorch was present on plants which had been grown with a complete nutrient solution and in addition had 25 grams per crock of calcium carbonate mixed with the sand when the bulbs were potted.

Similar results were obtained at Beltsville when dolomitic limestone was added to the infertile acid soil at the rate of 0, 1000, 4000, and 8000 pounds per acre when the bulbs were potted. The heaviest application of the limestone when combined with nitrogen fertilizer applications during forcing produced plants with the least scorch. In Oregon, Roberts, et al. (2) was able to grow Croft lilies without scorch in a potting soil, which if untreated resulted in severe scorch. His treatment consisted of 8 tons (equivalent) of lime in the potting soil plus nitrogen, phosphorus, potassium, and sulfur applied in six feedings, at 1-week to 10-day intervals during forcing (2).

The experiments just described lend further support to the theory that the leaf scorch of Croft Easter lilies is due to unbalanced nutrition. It appears to be most severe in very acid soils and can be largely overcome by raising the soil reaction with heavy applications of calcium. It is probably that calcium does more than simply change the reaction. In less acid soils the addition of nitrogen alone has often tended to reduce the amount of scorch. The role of the nitrogen in this connection is not entirely clear nor is it certain whether scorch is due to toxic amounts of aluminum or manganese in the acid soil or to deficiency of calcium or magnesium usually present in such soils. Perhaps scorch development is an indication that both conditions are present in the bulbs or the soil. Further studies are in progress to learn the optimum amounts of lime and nitrogen for controlling scorch when various types of soils are used during forcing.

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FERTILIZER AND LIME AFFECT AMOUNT OF LEAF SCORCH IN CROFT EASTER LILIES

By Neil W. Stuart[1] K. S. Nelson[2], and D. C. Kiplinger[3]

Croft Easter lilies are sometimes subject to a disfiguring injury which spots or scorches the leaves as the plants approach the blooming stage. This injury apparently is not caused by a fungus, bacterial, or virus disease but seems to be related to the reaction and fertility of the soil in which the bulbs are grown and forced. Experiments have shown that the leaf scorch is most severe when the plants are grown in strongly acid, infertile soil. Addition of nitrogen fertilizer during forcing has often reduced the amount of scorch. The effectiveness of the treatment seems to depend somewhat upon the nitrogen carrier as well as the fertility level and reaction of the soil. For example, we found (Ohio Florists' Association Bulletin No. 268, January, 1952) that when ammonium sulfate was used with neutral or slightly alkaline soil at Columbus, Ohio, the amount of scorch was reduced below that present in the unfertilized plants. When the same treatment was used on a slightly acid soil at Beltsville, Maryland, the amount of scorch was increased greatly as ammonium sulfate made the soil more acid.

Addition of lime to Croft lily potting soil has been recommended although the best carrier, time, and rate of application are not well established. The purpose of the present report is to describe further cooperative lily forcing tests made at Columbus, Ohio, and Beltsville, Maryland.

Experiment 1

A case of 8- to 9-inch Croft lily bulbs, furnished through the courtesy of Geo. J. Ball, Inc., West Chicago, Illinois, was received at Beltsville and stored at 35° F. on October 27, 1952. On December 8 half of the bulbs were sent by express to Columbus where they were potted on December 13 in soil having a pH of 7.8. The remaining bulbs were potted at Beltsville on December 15 in soil with a pH of 5.6. The 100 pots were arranged in 10 groups of 5 in each of two locations on ground beds in a greenhouse maintained at a night temperature of 60° F. At Columbus the two locations were on adjacent raised benches in a greenhouse. Each group of 5 pots at one location in the greenhouse at Beltsville received a different fertilizer treatment and the 10 treatments were repeated at the other location. The fertilizer treatments and procedure were the same at Columbus as at Beltsville.

The first 8 treatments involved all possible combinations of either low or high amounts of nitrogen, phosphorus, and calcium (table 1). Low phosphorus and calcium meant that none was added to the soil when the bulbs were potted or during forcing. Previous tests have shown that withholding nitrogen from lilies results in such poor growth that the plants are scarcely salable. Therefore in this test ammonium sulfate solution, 1 ounce in 2 gallons of water, was applied to soil for all plants in the low nitrogen treatments at 4-week intervals. Potassium, not a variable in this test, was also applied to soil for all plants at 4-week intervals as a solution of 1 ounce of potassium chloride in 2 gallons of water.

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High nitrogen (treatments 5 to 8) was supplied by making weekly applications of the ammonium sulfate solution at the same concentration as used for the 4-week application in treatments 1 to 4, table 1. Lilies in the high phosphorus treatment were potted in soil to which superphosphate was added at the rate of 2 ounces for seven 6-inch pots. (This is equivalent to a 4-inch pot per 2½ bushels of soil.) Every 2 weeks ¼ teaspoonful of monocalcium phosphate was added to each pot in treatments 3, 4, 7, and 8. High calcium was provided by mixing 2 ounces of hydrated lime in the soil for 7 pots when the bulbs were planted and adding 1 teaspoonful of the same material at 2-week intervals (treatments 2, 4, 6, and 8, table 1).

Two additional groups of plants each given the low nitrogen, low phosphorus, and low calcium treatment were also supplied at 2-week intervals with either aluminum sulfate, 1 ounce per gallon (treatment 9), or manganous sulfate, 1 ounce per 2 gallons of water (treatment 10). The appropriate solutions were combined for each of the various treatments and approximately 3 quarts of solution was applied to 10 plants at each application.

Results

Examination of table 1 shows that the fertilizer treatments had much more effect on the amount of scorch than on the other forcing responses of the bulbs. In general, the plants at Beltsville bloomed slightly earlier, on shorter stems, and with a slightly higher bud count than did those at Columbus. There were more scorched leaves on the Beltsville plants and at both places there was a wide range in number of scorched leaves per plant within a treatment.

In table 2 it is quite apparent at both places the high nitrogen and high phosphorus treatments induced more scorch than the low concentrations of these elements. On the other hand high concentrations of calcium reduced the amount of scorch and overcame the injurious effects of the high nitrogen and phosphorus. High phosphorus applications reduced the pH of the soil at Beltsville only from an initial 5.6 to 5.5 (treatment 3) while the high nitrogen further reduced it to 3.9 (treatment 5). In both instances the high lime nearly or completely neutralized the soil and acidity reduced the amount of scorch (treatments 4 and 6).

The aluminum and manganese applications had little effect on the plants at Columbus but at Beltsville addition of aluminum lowered the pH and increased the amount of scorch while manganese had less effect on the pH but lowered the amount of scorch. These elements are usually more available in acid soils and it was thought that they might be concerned in scorch development. The same beneficial effect of manganese was also noted at Beltsville with a second lot of Croft Easter lilies, also furnished by Geo. J. Ball, Inc., that was stored at Columbus and forced there and at Beltsville with the fertilizer treatments which have just been described. These bulbs were slightly frozen during storage and forced somewhat more slowly than the ones just discussed. In other respects the results were similar to those obtained with the bulbs stored at Beltsville, and therefore the detailed data are not presented.

Experiment 2

A third lot of 8- to 9-inch Croft bulbs grown and supplied by Otto Turley, Harbor, Oregon, was stored at a temperature of 31° F. from October 15 until November 28, 1952.

Table 1. Results of forcing 8- to 9-inch Croft Easter lily bulbs potted December 15, 1952, at Beltsville, Maryland (Belt.) and December 13 at Columbus, Ohio (Col.)

Plot Number	Fertilizer treatment			Average blooming date (1953)		Average number of salable flowers per plant		Average height of plants (inches)		Number of scorched leaves on plants with:				Average number of scorched leaves per plant		Soil pH after blooming
										Fewest		Most				
	Nitrogen	Phosphorus	Calcium			Belt.	Col.	Belt.	Col.	Belt.	Col.	Belt.	Col.	Col.	Belt.	Belt.
1	Low	Low	Low	March 24	March 29	5.4	4.3	19.0	24.1	1	0	31	15	18	5	5.8
2	Low	Low	High	March 25	March 31	4.2	4.8	15.8	25.2	0	0	17	8	8	4	7.8
3	Low	High	Low	March 27	March 30	5.5	3.9	18.2	24.2	23	3	60	35	40	19	5.5
4	Low	High	High	March 26	March 29	4.9	5.4	17.6	28.1	4	0	24	21	14	7	7.1
5	High	Low	Low	March 27	March 29	5.3	3.5	18.7	21.7	23	9	87	43	60	26	3.9
6	High	Low	High	April 3	March 31	3.4	4.2	13.0	23.3	0	0	9	24	3	5	6.9
7	High	High	Low	March 28	March 30	4.9	3.6	15.4	20.0	37	21	67	54	54	38	4.2
8	High	High	High	March 30	March 29	4.5	4.4	15.6	23.9	2	0	28	21	11	6	6.5
9	Low	Low	Low	March 26	March 29	5.1	4.4	18.8	25.3	19	0	53	27	34	8	4.8
10	Low	Low	Low	March 26	March 30	5.2	4.4	18.2	28.4	0	0	13	37	5	11	5.4
Average: 1-10				March 27	March 30	4.8	4.3	17.0	24.4	11	3	39	28	25	13	

Table 2. Summary of the results of fertilizer treatments on leaf scorch

Plots	General fertilizer treatment	Ave. no. of scorched leaves on plants				Ave. no. of scorched leaves per plant	
		Fewest at		Most at			
		Belt	Col.	Belt.	Col.	Belt.	Col.
1-4	Low nitrogen	7	1	33	20	20	9
5-8	High nitrogen	16	8	48	36	32	19
1,2,5,6	Low phosphorus	6	2	36	22	22	10
3,4,7,8	High phosphorus	16	6	45	33	30	18
1,3,5,7	Low calcium	21	8	61	37	43	22
2,4,6,8	High calcium	2	0	20	18	9	6

when they were shipped by express to Beltsville. They were received on December 8, and 80 of them were potted and placed in the greenhouse the following day. There were 10 bulbs per treatment arranged in two blocks of 5 pots.

The fertilizer treatments had relatively minor effects on blooming date and the number of salable flowers per plant (table 3). Plants to which no fertilizer was applied (treatment 1) and those receiving the dried blood (treatment 5) were taller than the others and had light green leaves.

The fertilizer and lime applications had a great deal of effect on the soil reaction and amount of leaf scorch. On February 18 the 10 unfertilized plants had the most leaf scorch (treatment 1). Three weeks later the number of scorched leaves on these plants had increased from 25 to 117 while the corresponding numbers for the plants receiving ammonium sulfate were 17 and 341 (treatment 2). When the final counts were made on April 21 there were more than 50 scorched leaves per plant in this last treatment. The pH of the soil decreased from 6.1 when the bulbs were potted to 4.1 at the end of the experiment. On the other hand regular application of sodium nitrate increased the pH to 7.0 and reduced the number of scorched leaves (treatment 3). The mixture of sodium nitrate and ammonium sulfate maintained the soil reaction with little change but was not as effective as the sodium nitrate in reducing scorch (treatment 4). The heavy application of dried blood (treatment 5) was even less effective than the sodium nitrate-ammonium sulfate mixture.

Best scorch control was obtained when limestone was added to the potting soil and the sodium nitrate-ammonium sulfate solution was applied at 2-week intervals (treatment 6). Ten plants with this treatment had a total of only 1 scorched leaf at blooming time and only 7 on April 21. The same amount of calcium applied in the form of hydrated lime was only slightly less effective than the limestone (treatment 7). Although the limestone and hydrated lime were applied only at potting time the soil was still slightly alkaline at the end of the forcing period. An equivalent amount of calcium supplied by gypsum (treatment 8) had little effect on soil reaction and was the least effective of the 3 calcium materials for controlling scorch.

Discussion

The conditions responsible for leaf scorch in Croft lilies are still largely unexplained although progress toward

Table 3. Results of forcing 8- to 9-inch Oregon-grown Croft Easter lily bulbs potted December 9, 1952, at Beltsville, Maryland.

Fertilizer treatment	Average blooming date (1953)	Average number of salable flowers per plant	Average height of plants (inches)	Cumulative number of scorched leaves on 10 plants on				Soil pH after blooming
				February 18	March 11	March 31	April 21	
1. None applied	March 22	4.1	17.7	25	117	181	192	6.5
2. Ammonium sulfate 1 oz. per 2 gal. every 2 weeks	March 24	4.1	17.4	17	341	471	548	4.1
3. Sodium nitrate 1 oz. per 2 gal. every 2 weeks	March 23	4.3	16.3	0	18	58	94	7.0
4. Mixture of 4 parts sodium nitrate + 1 part ammonium sulfate, 1 oz. per 2 gal. every 2 weeks	March 21	4.7	16.4	2	74	153	183	6.4
5. Dried blood 9 gm. (0.32 oz.) per pot at potting	March 24	4.4	18.2	2	138	254	274	6.0
6. Calcium carbonate (limestone) 9 gm. (0.32 oz.) per pot at potting	March 25	3.9	16.2	0	1	1	7	7.7
7. Hydrated lime 6.7 gm. (0.24 oz. per pot at potting)	March 20	3.9	14.7	4	6	11	29	7.6
8. Calcium sulfate (gypsum) 15.5 gm. (0.55 oz.) per pot at potting.	March 24	4.0	16.1	1	12	50	87	5.9

solution of the problem is being made. The experiments discussed in this report confirm our earlier work with nitrogen and show that the use of moderate amounts of nitrogen with lime results in effective scorch control. However, it must be emphasized that different nitrogen carriers may affect the degree of scorch control. If, like ammonium sulfate, they leave an acid recation and no lime is applied the amount of scorch may actually be increased.

Liming materials control scorch and appear, in some degree, to overcome unfavorable influences of excessive amounts of nitrogen and phosphorus. It would appear to be a good practice to mix limestone with the potting soil if its reaction is much lower than pH 7.0. Undoubtedly the best amount to apply will depend upon the particular soil and fertilizer practice. An amount of limestone equivalent to 5 tons per acre, approximately one-third ounce per 6-inch pot. at potting and bi-weekly applications of nitrogen during forcing resulted in excellent growth and virtually perfect scorch control.

It should be pointed out that while relatively large amounts of limestone or hydrated lime are not damaging to Croft lilies excessive amounts of nitrogen and phosphorus may increase the amount of scorch. Other investigators have found also that deficient or excessive amounts of certain elements may increase the amount of leaf scorch. In this connection the unexpected beneficial effects from manganese encountered in some of the presents tests needs further study. Until such time as the factors responsible for leaf scorch are better understood the best control practice seems to be liberal use of lime. moderate use of nitrogen. and avoidance of acid soil conditions.

TESTS ON CROFT LILIES

Within recent years the problem of root rot on Croft lilies has been of major concern to the florist. Loss of root action has resulted in inferior plants with poor keeping quality in the home. Isolations made from rotted roots have revealed various fungi, but it is not too clear whether they have caused the rot or as a result of the roots rotting are simply growing on the dead or dying tissue.

Various bulb dips and/or soil drenches have been advocated by research workers, and one that received widespread publicity was a combination of an insecticide and a fungicide. The insecticide presumably would take care of insects or allied pests that might carry spores of fungal organisms while the fungicide would kill the organisms that were present on the bulb.

Procedure

An evaluation of such treatment was made on 7 to 8-inch, single nose Croft lilies in 1956-57. Bulbs were donated by Alec Henderson, Inc., Chicago, Illinois, and Vaughan's Seed Company, Chicago, Illinois. The bulbs were sorted for uniformity and 12 bulbs from each source after being subjected to the following treatments were planted in unsterilized soil and 12 others from each source in steam sterilized soil:

1. Check—potted without any treatment.
2. Soaked 30 minutes in tap water.
3. Soaked 30 minutes in a solution of 2 oz. of 15% parathion in 5 gallons, 2 oz. Fermate in 6 gallons, and ½ cup of Lysol in 6 gallons. Eight weeks after potting the soil was drenched with a solution of 2 oz. of 15% parathion in 5 gallons of water.
4. Soaked 30 minutes in a solution of 2 oz. of 15% parathion in 5 gallons.
5. Soaked 30 minutes in a solution of 2 oz. of Fermate in 6 gallons.
6. Soaked 30 minutes in a solution of ½ cup of Lysol in 6 gallons.
7. Soaked 30 minutes in a solution of Endrin at 1-400.
8. Soaked 30 minutes in a solution of Panodrench at 1 teaspoonful per gallon.
9. Soaked 30 minutes in a solution of Panodrench at 1 teaspoonful per gallon followed by soil drenches of Panodrench at 1 teaspoonful per gallon on Feb. 1 and Mar. 1.

The potting mixture was 3 parts soil and 1 part rotted manure, and that which was steamed was kept at 180° F. for 30 minutes. The bulbs were potted in 5-inch clay pots on Dec. 31, 1956, placed at 60° F. and kept at this temperature through flowering. A 20-20-20 fertilizer was applied at 1 oz. per 3 gallons every 2 weeks from the time the shoots were 2 inches above the nose of the bulb.

No attempt was made to isolate or identify any organisms that were present on rotted roots.

Appearance or condition of the root system

Just before flowering each plant was knocked out of the pot and the root system was examined and classified as either healthy, fair, or dead. Root systems were classified as healthy when three-fourths or more of the visible roots were white. A fair root system was one where approximately ¼ to ¾ of the root system had died. A dead root system was where less than ¼ of the root system was still alive. The results of this evaluation are shown in Table 1.

It is evident from the averages that steaming the soil was beneficial insofar as the health of the root system was concerned. In unsterilized soil the best treatment appeared to be a Panodrench soak followed by drenchings with the material. The combination insecticide and fungicide soak was not conducive to development of a healthy root system and the Lysol treatment alone was similar. In sterilized soil there was little difference between Endrin and either Panodrench treatments.

Extent or development of the root system

At the time of recording the relative condition of the roots as previously described, an evaluation of the extent or development of the roots around the soil ball was also made. Such an evaluation is relative, of course, depending upon the individual making the rating, but the usual accepted criteria of a good, fair, and poor root system formed the basis of the ratings. Table 2 shows the data.

TABLE 1

Appearance or condition of the root system as affected by various treatments of bulbs planted in unsterilized and sterilized soil.

Treatment	Soil not sterilized: Per cent of plants where appearance or condition of the root system was			Sterilized soil: Per cent of plants where appearance or condition of the root system was		
	Healthy	Fair	Dead	Healthy	Fair	Dead
1. Check	38	46	16	50	38	12
2. Water soak	38	50	12	75	17	8
3. Parathion, Fermate, & Lysol soak	17	20	63	43	22	35
4. Parathion soak	50	38	12	70	22	8
5. Fermate soak	54	38	8	63	29	8
6. Lysol soak	21	54	25	63	37	0
7. Endrin soak	50	25	25	83	4	13
8. Panodrench soak	57	39	4	92	8	0
9. Panodrench soak plus drenchings	71	21	8	83	13	4
Average	44	37	19	69	21	10

TABLE 2

Extent or development of the root system as affected by various treatments of bulbs planted in unsterilized and sterilized soil.

Treatment	Soil not sterilized — Per cent of plants where extent or development of the root system was: Good	Fair	Poor	Sterilized soil — Per cent of plants where extent or development of the root system was: Good	Fair	Poor
1. Check	54	38	8	88	8	4
2. Water soak	54	33	13	75	25	0
3. Parathion, Fermate, & Lysol soak	17	17	66	57	30	13
4. Parathion soak	59	33	8	91	9	0
5. Fermate soak	75	25	0	92	8	0
6. Lysol soak	46	33	21	71	29	0
7. Endrin soak	63	33	4	92	0	8
8. Panodrench soak	65	35	0	100	0	0
9. Panodrench soak plus drenchings	79	21	0	88	22	0
Average	57	30	13	84	14	2

Here again root systems were better in sterilized soil than in soil not steamed. In the unsterilized soil bulbs soaked in Fermate and Panodrench treatment No. 9 were high in the good root category. In the steamed soil the treatments with the lowest ratings—water soak, combination insecticide and fungicide, and Lysol—were rather far behind any other treatment. Even doing nothing to the bulbs in steamed soil as far as chemical treatment was concerned was quite satisfactory.

Height, flowers, and blasts

Records taken on these are given in Table 3. There was a slight inhibiting effect on height of bulbs treated with the combination insecticide-fungicide but the average of all treatments in steamed and unsteamed soil was very similar.

There was approximately one-half a flower per plant difference in favor of bulbs planted in steamed soil, and when comparing the average on blasts, there was one-half a flower per plant difference again in favor of steamed soil, making a net gain of one flower.

Conclusions

Considering the fact that no distinct trends were noted in chemical treatment, it would not appear that such a method could be relied upon to prevent root rot. If only the bulb itself is treated, little protection against soil organisms could be expected on the roots which develop away from the bulb itself. Furthermore the "waxy" nature of the bulb makes it difficult to get complete coverage by the chemical in between the closely packed scales at the base and probably not all of the organisms are eliminated.

Steaming the soil was beneficial in terms of healthier root systems, larger root systems, a greater number of flowers per plant, and a fewer number of blasted buds per plant.

TABLE 3

Height of plants, flowers per plant, and blasted buds per plant as affected by various treatments of bulbs planted in unsterilized and sterilized soil.

Treatment	Ave. height of plants above pot (inches): Soil not ster.	Ster. soil	Ave. No. of flowers per plant: Soil not ster.	Ster. soil	Ave. No. of blasted buds per plant: Soil not ster.	Ster. soil
1. Check	21	20	2.9	3.6	0.7	0.2
2. Water soak	19	19	2.7	3.3	0.6	0.4
3. Parathion, Fermate, & Lysol soak	16	18	1.8	2.9	1.2	0.3
4. Parathion soak	18	21	2.8	3.6	1.0	0.3
5. Fermate soak	21	20	3.2	3.9	0.6	0.3
6. Lysol soak	18	20	2.8	3.1	0.5	0.1
7. Endrin soak	19	21	2.7	3.3	0.7	0.3
8. Panodrench soak	21	21	3.1	3.7	0.5	0.1
9. Panodrench soak plus drenchings	21	21	3.2	3.3	0.5	0.3
Average	19	20	2.8	3.4	0.7	0.2

COMPARATIVE DEVELOPMENT OF ACE AND NELLIE WHITE LILIES

Dennis Rider and D. C. Kiplinger
Ohio Agr. Exp. Sta.
Wooster, Ohio

There is an old "rule of thumb" that lily buds should be visible in the leaf clusters 6 weeks before Easter and should be just bending over 2 weeks prior to Easter if the night temperature of the greenhouse is maintained at 60°F. This has proven to be a rather reasonable guide, but there appears to be need for additional information relative to the stage of development before 6 weeks prior to Easter so lily forcers would know whether their plants were on schedule. The purpose of this test was to determine if it would be possible to establish some criteria relative to bud size, number of leaves, or height of plants using the lilies Ace and Nellie White (selection of Croft that is said to flower somewhat earlier).

Bulbs of both types (6½- to 7-inch size) were received through the courtesy of Robert Hastings, Box 56, Harbor, Oregon, the week of November 17, 1960, and the cases were placed at 33°F until the bulbs were potted on December 12, 1960, in a well-drained soil (equal parts of soil, coarse sand, and peat). The night temperature was maintained at 60°F throughout the course of the experiment and no attempt was made to either force or retard plant growth by manipulation of temperature. A complete fertilizer, 40-3-3, was applied at 1 oz. per 3 gal. each week and general culture was similar to that which would be given in a commercial florist greenhouse.

The plants were sorted for uniformity of both height and relative development and examinations were made beginning Friday, January 13, 1961, (11 weeks before Easter) on the basis that the plants should be "just" in flower on the Friday before Easter. The data recorded were the number and size of flower buds present, the height of the plants, and the number of leaves on the plant. There were 15 plants of Ace and 20 of Nellie White per plot.

TABLE 1.—BUD COUNT AT VARIOUS DATES

Week of				
2/10	2/17	2/24	3/3	3/10 on
		Average Number of Buds on Ace		
5.0	5.0	5.6	5.5	5.5
		Range in Number of Buds on Ace		
2 with 3	1 with 3	2 with 4	1 with 4	1 with 4
1 with 4	3 with 4	7 with 5	6 with 5	7 with 5
7 with 5	6 with 5	4 with 5	8 with 6	5 with 6
5 with 6	5 with 6	1 with 8		2 with 7
		Average Number of Buds on Nellie White		
4.1	5.0	4.9	4.8	4.3
		Range in Number of Buds on Nellie White		
6 with 3	4 with 3	1 with 3	3 with 3	1 with 3
7 with 4	3 with 4	7 with 4	2 with 4	13 with 4
6 with 5	4 with 5	6 with 5	9 with 5	6 with 5
1 with 6	9 with 6	6 with 6	1 with 7	

Average Number of Buds

It was not possible to count the number of buds with the naked eye until February 10 (7 weeks prior to Easter) because the tissues involved were not sufficiently developed. Hence information on relative size of buds at various dates prior to the time of 6 weeks before Easter was impossible to obtain but data on later dates are shown. It should be explained that the stem tips were cut with a scalpel and each group of plants examined up to March 10 was discarded, hence the bud count will vary due to different plants being examined. After March 10, measurements could be made without injury to the buds. The data are shown in Table 1.

The data are self-explanatory and no discussion is needed.

Average Length of Buds

Since bud number could not be determined until the date of February 10, neither could bud length and the data obtained are presented in Table 2.

Several things are of interest from the data. There was a tremendous range in bud length with both Ace and Nellie White from February 17 until end of March at which time flowering occurred. Such a range makes it hazardous to estimate the timing of a crop based on bud size unless a number of plants are examined.

Note that with Ace, marked differences in the rate of elongation are shown in the figures in parenthesis beginning after the week of March 3, whereas with Nellie White the initial differences were larger than with Ace and the rather large differences were later, beginning the week of March 17.

Flowering dates were only 4 days apart which would appear to indicate that if Nellie White is supposed to be early, Ace is not a slow grower either (see OFA Bulletin No. 374, November, 1960, which confirms this).

Average Height of Plants

Instead of measuring from the pot rim, height measurements were made from the lowest visible scale-leaf which joined the stem at or slightly below the soil line. The top was more difficult to define. As the plant was viewed from the side, the youngest leaves of Ace were in a definite vertical position with little or no evidence of bending outward. The younger or newest leaves held together in a cylindrical shape at the top and the tips of these leaves varied in height only about one-fourth inch. The top was considered as being halfway between the tips of the leaves forming this cylinder. With Nellie White the younger leaves formed a cylinder and bent away from the vertical as with Ace but the unfolding leaves curved about 90° just back from the tip. This angle formed a plane which was easily distinguished as a top which served as a measuring point.

It should again be mentioned that at each measuring date up to March 10 a different group of plants were used

TABLE 2.—BUD LENGTH AT VARIOUS DATES IN INCHES

Week of										
2/10	**2/17**	**2/24**	**3/3**	**3/10**	**3/17**	**3/24**	**3/31**	**4/7**	**4/14**	**4/21**
Average Length of Buds on Ace										
5/32	8/32	13/32	19/32	1-2/32	1-22/32	2-31/32	4-1/32	3-16/32	3-8/32	5
	(3/32)	(5/32)	(6/32)	(15/32)	(21/32)	(1-9/32)	(1-2/32)			
Range in Length of Buds on Ace										
From 3/32 to 8/32	From 3/32 to 12/32	From 5/32 to 22/32	From 4/32 to 30/32	From 12/32 to 1-14/32	From 23/32 to 2-16/32	From 1 to 4-24/32	From 1-16/32 to 5-8/32 2 flowered	From 1-12/32 to 5 12 flowered	3-8/32 14 flowered	5 14 flowered
Average Length of Buds on Nellie White									**Average date of flowering of Ace—4/6/61**	
5/32	12/32	18/32	29/32	1-9/32	1-29/32	3-23/32	4-26/32	5-16/32		
	(7/32)	(6/32)	(11/32)	(12/32)	(20/32)	(1-26/32)	(1-3/32)	(22/32)		
Range in Length of Buds on Nellie White										
From 2/32 to 12/32	From 5/32 to 26/32	From 10/32 to 30/32	From 18/32 to 1-8/32	From 24/32 to 1-24/32	From 1-4/32 to 2-20/32	From 2 to 5-8/32	From 2-24/32 to 6 5 flowered	From 5 to 6 18 flowered	**Average date of flowering of Nellie White—4/2/61**	

TABLE 3.—HEIGHT AT VARIOUS DATES IN INCHES

Week of														
1/13	**1/20**	**1/27**	**2/3**	**2/10**	**2/17**	**2/24**	**3/3**	**3/10**	**3/19**	**3/24**	**3/31**	**4/7**	**4/14**	**4/21**
Average Height of Ace														
2-3/8	3-3/8	3-7/8	4-3/8	4-3/8	4-7/8	5-4/8	6-4/8	8-1/8	10	12	13	14-1/8	15-4/8	15-4/8
Range in Height of Ace														
From 2 to 3	From 3 to 4-2/8	From 3-4/8 to 4-4/8	From 3-4/8 to 5	From 4 to 5	From 4 to 5-4/8	From 4-4/8 to 7	From 5 to 7-4/8	From 6 to 10	From 6 to 12	From 8-4/8 to 14-4/8	From 9 to 15	From 12 to 15-4/8 12 flowered	15-4/8 14 flowered	15-4/8 14 flowered
Average Height of Nellie White														
2-7/8	3-3/8	3-6/8	4-2/8	4-3/8	4-6/8	5-4/8	6-5/8	7-2/8	8-6/8	9-7/8	10-5/8	10-2/8		
Range in Height of Nellie White														
From 2-1/8 to 3-4/8	From 2-6/8 to 4	From 3-2/8 to 4-2/8	From 3-6/8 to 5-6/8	From 3-6/8 to 5	From 4 to 6-4/8	From 4-4/8 to 6-6/8	From 5-4/8 to 7-4/8	From 5-4/8 to 9	From 6 to 10	From 8 to 12	From 9 to 13 5 flowered	From 10 to 10-4/8 18 flowered		

TABLE 4.—LEAF COUNT AT VARIOUS DATES

Week of								
1/13	**1/20**	**1/27**	**2/3**	**2/10**	**2/17**	**2/24**	**3/3**	**3/10 on**
Average Number of Leaves on Ace								
18.5	20.9	29.8	44.7	50.8	49.9	63.9	65.4	71.1
Range in Number of Leaves on Ace								
From 14 to 25	From 16 to 30	From 25 to 36	From 32 to 57	From 42 to 59	From 38 to 59	From 51 to 77	From 64 to 78	From 65 to 79
Average Number of Leaves on Nellie White								
16.0	23.1	29.8	40.0	43.5	54.1	61.7	70.9	71.9
Range in Number of Leaves on Nellie White								
From 11 to 24	From 13 to 27	From 25 to 35	From 34 to 48	From 36 to 48	From 42 to 67	From 51 to 69	From 60 to 82	From 61 to 93

(each previous batch was ruined in making bud counts). The data are shown in Table 3.

As most florists know, height of lilies is quite variable—at one greenhouse they may be short whereas similar bulbs in similar soil handled nearly the same may be tall. These data indicate variability in height even when sorted for uniformity at the start of the measurements (1/13) and we doubt if height is a reliable index of maturity.

Average Number of Leaves

Leaf counts were made beginning with leaves at the base of the stem which were 2½ inches or greater in length. The leaves which formed the cylinder as described under "Height" were not counted because it was difficult to determine with the naked eye which were leaves and which were buds until the week of February 24 with the Ace and February 17 with Nellie White. This accounts for the abrupt increase in numbers of leaves the week following these dates as shown in Table 4.

As with the height, there was considerable variation in the number of leaves at any one date, and it appeared as if this would not be a satisfactory basis for determining the relative stage of development.

Summary and Conclusions

A study was run to determine if one or more criteria could be used to determine the relative stage of development or maturity on Ace and Nellie White (Croft selection) lilies. It was hoped that the old rule of thumb "6 weeks before Easter at 60°F, buds should be visible" could be extended so florists would know earlier than this date if their lilies were on time.

Of all the various data recorded in relation to relative maturity (length of buds, height of plants, and number of leaves), only length of buds offered any real promise of being suitable. Unfortunately, it is difficult to determine with the naked eye, the size of buds prior to 7 weeks before Easter which indicates that this method is unsuitable. Undoubtedly a good hand lens would be of help and the study for next year will be continued on this basis.

Great variability existed in height of plants and number of leaves at any one date of measurement.

Bud count was extremely good for these relatively small bulbs (6½- to 7-inch). Undoubtedly a well-drained soil, careful watering, regular fertilization, uniform night temperatures, and exposure to the best possible light conditions aided in this respect.

There was little difference in date of flowering between the two types of lilies. Ace averaged 4 days later but had the night temperature been manipulated, it would have been possible to flower the plants by Easter, April 2.

In order to make Easter and still permit "hardening" the plants at cooler temperatures, it would appear that flower buds ought to be about ½ inch long 5 weeks before Easter at a forcing temperature of 60°F.

EXPERIMENTS WITH POTTED LILIES, 1961-1962

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Two tests of primary interest were run last year on potted lilies. They were concerned with the effect of preplanting handling and length of precooling on bud count and height as well as the relative stage of plant development at various dates before Easter.

I. Preplanting Handling and Length of Precooling

Background — Before the practice of precooling lilies became a standard procedure, florists would pot the bulbs and place them in a cool location such as a coldframe and then around Christmas bring them in for forcing (widely practiced on the West Coast today). There were a number of disadvantages to the system as might be suspected—lack of uniformity of cooling due to weather variations, inability to cool properly in southern areas, loss from animals, freezing, etc., and last but not least, the labor of moving the pots. Precooling enabled the florist to pot the bulbs and place them immediately on the bench for forcing, though reduced bud count and a bare stem appearance caused by dwarfed lower foliage was the result of using precooled bulbs.

In the interest of improved bud count and an overall better quality product, there has been awareness on the part of many lily forcers that a return to the use of non-precooled bulbs might be worthy of consideration. This experiment was set up to compare the effects of cooling while in dry storage with that of cooling while potted and forming roots.

Procedure — That part of the experiment performed at Columbus is reported below, and the results of a more detailed study at Wooster will be presented later. Ace lilies, 7- to 8-inch size, were obtained from the Geo. J. Ball, Inc., West Chicago, Illinois, and these were sent to Columbus immediately after digging by the producer, Mr. William Fisher of Crescent City, Calif., arriving on Oct. 30, 1961. These bulbs had received no refrigeration either in California or in transit. The bulbs were sorted for uniformity, and 20 were potted on Nov. 1 and placed in the greenhouse. The remaining bulbs were divided into four lots of 240 each and handled as follows:

1) Placed in dry peat in a 33°F refrigerated storage with 20 bulbs to be potted each week and placed in the greenhouse over a 12-week period.

2) Potted and then placed in a 33°F refrigerated storage with 20 pots to be taken out each week and placed in the greenhouse over a 12-week period.

3) Placed in dry peat in a frame where the temperature would not be allowed to drop below 35°F with 20 bulbs to be potted each week and placed in the greenhouse over a 12-week period.

4) Potted and then placed in a frame (same as #3) with 20 pots to be taken out each week and placed in the greenhouse over a 12-week period.

The bulbs were potted in a steamed mixture of 2 soil, 1 Perlite, and 1 peat so the noses were 2 inches below the soil surface (provides anchorage from stem roots). When shoots were visible through the soil, a 10-3-3 fertilizer was applied at 1 oz. per 3 gal. every 2 weeks. The night temperature was maintained at 60°F—no attempt was made to force or hold back the plants by temperature regulation.

Data were taken on flowering date, height of plants above the pot, and the number of salable flowers and this information is shown in Table 1.

Results — Easter was April 21 in 1962 and the first groups of plants to flower by this date were those kept at 33°F (plots 14, 15, 18, 19, 22, 23, 26, and 27). Not until 7 weeks of storage took place did the average date of flowering occur by Easter on bulbs held in the frame (plot 29).

In general, the longer the bulbs were held at 33°F, the more rapidly did they flower when brought into the greenhouse. This, of course, has long been known by growers and research men, but it is of interest to point out that bulbs held at 33°F for 9, 10, 11, or 12 weeks did not flower by Easter because of the late date of starting to force them in the greenhouse.

A study of the maturity dates of the plants in the various plots reveals that after the first week of storage, bulbs held in the 33°F storage flowered in advance of those in the frame—whether in dry peat or potted. Undoubtedly the uniformity of cool temperature in the refrigerated storage brought about more rapid precooling than in the frame where the temperature varied depending upon the weather.

It is generally stated that commercially precooled (usually 6 weeks) Ace liles will force in 120 days or 17 weeks when kept at 60°F. Note that potted bulbs held at 35°F for 7 weeks (plot 27) and bulbs held in dry peat for 8 weeks (plot 30) were the first to flower in less than 17 weeks as shown by the figures in the right hand column. Of course it should be stated that the bulbs held 6 weeks at 33°F (plots 22 and 23) could easily have been forced into flower by Easter simply by raising the temperature somewhat, but this was not the purpose of the test.

Table 2 shows data based on the average of bulbs in any group of similar treatments. It is of interest to note that bulbs in the 33°F storage were shorter at maturity than those kept in the frame, and also that bud count on potted bulbs was higher than on bulbs stored in dry peat. This latter information is one reason why there is so much interest in a return to the old method of handling since it is possible to maintain good bud count by early planting so the root system will be reasonably well developed before the plants are brought into the greenhouse. Evidently when commercially precooled bulbs are potted and placed in the

Table 1.—The effect of several methods of handling prior to forcing on the flowering date, height of plants, number of flowers, and time required for flowering of Ace lilies.

Plot	Treatment	Date Potted	Date Brought Into Greenhouse	No. of Weeks Stored	Ave. Date of Flowering	Ave. Height Above Pot—inches	Ave. No. of Salable Flowers	Ave. No. of Weeks to Flowering	
								From Potting	From Date Brought Into Greenhouse
1	Potted on arrival	11/1	11/1	0	6/3	23.1	4.6	31.3	31.3
2	33°, dry	11/8	11/8	1	5/28	21.1	5.3	28.8	28.8
3	33°, potted	11/1	11/8	1	5/27	21.1	5.5	29.6	28.6
4	Frame, dry	11/8	11/8	1	5/27	20.9	5.2	28.6	28.6
5	Frame, potted	11/1	11/8	1	5/21	19.2	5.7	28.7	27.7
6	33°, dry	11/15	11/15	2	5/7	15.7	5.8	24.6	24.6
7	33°, potted	11/1	11/15	2	5/8	15.9	6.3	26.9	24.9
8	Frame, dry	11/15	11/15	2	5/19	19.0	5.7	26.4	26.4
9	Frame, potted	11/1	11/15	2	5/17	19.8	5.8	28.1	26.1
10	33°, dry	11/22	11/22	3	4/26	15.0	5.6	22.2	22.2
11	33°, potted	11/1	11/22	3	4/25	13.0	6.3	23.8	20.8
12	Frame, dry	11/22	11/22	3	5/17	19.0	5.1	29.4	29.4
13	Frame, potted	11/1	11/22	3	5/13	18.9	6.8	27.7	24.7
14	33°, dry	11/29	11/29	4	4/18	12.0	5.6	20.1	20.1
15	33°, potted	11/1	11/29	4	4/18	13.7	6.4	23.8	19.8
16	Frame, dry	11/29	11/29	4	5/7	16.2	5.8	22.7	22.7
17	Frame, potted	11/1	11/29	4	5/9	17.6	6.8	27.3	23.6
18	33°, dry	12/6	12/6	5	4/17	14.8	5.6	18.8	18.8
19	33°, potted	11/1	12/6	5	4/15	14.1	5.9	23.3	18.3
20	Frame, dry	12/6	12/6	5	5/6	17.9	5.6	21.6	21.6
21	Frame, potted	11/1	12/6	5	4/29	16.0	6.7	25.6	20.6
22	33°, dry	12/13	12/13	6	4/16	13.9	5.4	17.8	17.8
23	33°, potted	11/1	12/13	6	4/16	13.8	6.0	23.6	17.6
24	Frame, dry	12/13	12/13	6	5/2	14.9	5.6	19.9	19.9
25	Frame, potted	11/1	12/13	6	4/22	12.9	5.8	24.6	18.6
26	33°, dry	12/20	12/20	7	4/20	13.1	4.9	17.3	17.3
27	33°, potted	11/1	12/20	7	4/16	14.8	6.0	23.7	16.7
28	Frame, dry	12/20	12/20	7	4/29	16.4	5.3	18.9	18.9
29	Frame, potted	11/1	12/20	7	4/20	12.5	6.0	24.3	17.3
30	33°, dry	12/27	12/27	8	4/21	12.0	4.3	16.5	16.5
31	33°, potted	11/1	12/27	8	4/21	12.4	4.2	24.4	16.4
32	Frame, dry	12/27	*						
33	Frame, potted	11/1	*						
34	33°, dry	1/3	1/3	9	4/23	12.9	4.5	15.7	15.7
35	33°, potted	11/1	1/3	9	4/23	12.5	4.2	24.7	15.7
36	Frame, dry	1/3	*						
37	Frame, potted	11/1	*						
38	33°, dry	1/10	1/10	10	4/28	12.8	4.0	15.1	15.1
39	33°, potted	11/1	1/10	10	4/29	12.6	4.7	26.5	16.5
40	Frame, dry	1/10	*						
41	Frame, potted	11/1	*						
42	33°, dry	1/17	1/17	11	4/27	13.9	4.0	13.9	13.9
43	33°, potted	11/1	1/17	11	5/1	13.0	4.8	25.8	14.8
44	Frame, dry	1/17	*						
45	Frame, potted	11/1	*						
46	33°, dry	1/24	1/24	12	5/7	14.3	4.2	14.7	14.7
47	33°, potted	11/1	1/24	12	5/5	13.7	4.6	26.4	14.4
48	Frame, dry	1/24	*						
49	Frame, potted	11/1	*						

* Plants in these plots were lost due to breakage of a hot water line in the frame which inundated the pots with water at 160° F.

Table 2.—Summary of data based on the average of plants in similar treatments.

Treatment	Ave. Height Above Pot—inches	Ave. No. of Salable Flowers
33°F, dry	15.1	5.5
33°F, potted	15.2	6.1
Frame, dry	17.8	5.5
Frame, potted	16.7	6.2

greenhouse, growth of roots and shoots simultaneously causes a reduction in food supply so some buds either (1) fail to initiate, (2) abort, blast, or otherwise fail to develop, or (3) both may occur.

Suggestions — Based on practices followed on the West Coast and the results of this preliminary test, it would appear that there is merit in potting the bulbs and then precooling them. Though the plants in the frame were somewhat slower than those placed in the 33°F storage, there might be a combination of the two methods that could be useful. In order to speed the development of a root system, the bulbs could be potted and remain at a temperature of 60°F or higher for several weeks. Then the temperature would be lowered to 33°F or thereabouts to bring about precooling which is necessary for rapid forcing. Instead of moving the pots, they could initially be placed in a storage equipped for refrigeration, but not operated until the desired root growth had taken place. Such a practice needs investigation but appears to be worthy of trial on a small scale.

II. Relative Development of Ace Lilies

Last year a study was run on the comparative development of Ace and Nellie White lilies with the objective of attempting to obtain further information on timing. Lily growers are familiar with the statement that buds should be visible in the leaf clusters six weeks before Easter or bending over two weeks before Easter when grown at 60°F. The purpose was to determine if it would be possible to establish such guide posts in advance of the period six weeks before Easter so a grower could force or retard the growth. Very briefly in last year's tests, length of buds was the best criteria in determining development since height of plants and number of leaves were not reliable. Examinations were made with the naked eye and it was difficult to determine bud lengths prior to seven weeks from Easter.

In the 1961-62 tests, only the Ace lily was used and bulbs were obtained through the courtesy of Mr. Robert Hastings, Box 56, Harbor, Oregon. Commercially precooled bulbs of 7- to 8-inch size were potted on December 22, 1961, which was 120 days before Friday, April 20, 1962, when the plants should be ready for sale for Easter on April 22. The bulbs were handled in the usual commercial manner and were kept at 60°F nights throughout the test. There were 20 plants in each plot.

Examination of the stem tips was made with the aid of a binocular microscope (magnification of 10.5x) beginning on February 2 which was 11 weeks prior to April 20, and examinations were made on a weekly basis. Though height was found to be a poor index of maturity, as a matter of course, the plants were sorted for uniformity at the time of the first examination and the shortest and tallest were not used in the test.

Average Number of Buds

The bud count is given in Table 3 and it is important to remember that examinations were made on a different group of plants each week, hence the bud count will vary. The data are self-explanatory.

Average Length of Buds

The data are presented in Table 4. There is a rather wide range in bud size which would mean that a number of plants would have to be examined in order to have a representative sample. The figures in parenthesis are the differences in growth measurements each week and there is an incrasing amount of elongation after mid-February until near the very end of the season when the rate slows down.

Average Height of Plants

Instead of measuring from the pot rim, height measurements were made from the lowest visible scale leaf which joined the stem at ar below the soil line. The top is more difficult to define. As the plant was viewed from the side, the youngest leaves were in a definite vertical position with little or no evidence of bending outward. The younger or newest leaves were grouped together in a cylindrical shape at the top and the tips of these leaves varied in height only about one-fourth inch. The top was considered as being halfway between the tips of these leaves forming this cylinder. Different plants were measured each week which accounts for the seeming irregularity of data from 3/2 to 3/9 and 4/6 to 4/13 in Table 5.

As lily growers know, height of the plants can be quite variable and it is doubtful if this measurement can be used satisfactorily as an index of maturity.

Average Number of Leaves

Leaf counts were made beginning with leaves at the base of the stem which were 2½ inches or greater in length. The leaves which formed the cylinder as described under "Height" were not counted the first two weeks because of difficulty in separating the very smallest leaves in the cluster. By mid-February, however, it was possible to count all leaves and this is why the number of leaves increases markedly from 2/9 to 2/16. The data are shown in Table 6.

Conclusions

At the time of six weeks before Easter, the flower buds are approximately three-fourths inch long which is a clearly visible size. Prior to this, buds are not easily measured without the aid of some type of magnifying glass and it is doubtful if a great deal can be gained since the disturbance of the protecting leaves around the buds causes the buds to either dry and die or grow very poorly. It would appear that six weeks prior to Easter is still the best "yardstick" for determining the timing of the crop for Easter. Height and numbers of leaves did not appear to be reliable indices of relative development.

TABLE 3.—BUD COUNT AT VARIOUS DATES

Week Of

2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13
Average Number Of Buds										
5.5	5.7	5.9	6.5	6.5	5.9	6.0	6.0	6.0	6.0	5.9
Range In Number Of Buds										
10 with 5 10 with 6	7 with 5 13 with 6	5 with 5 12 with 6 3 with 7	3 with 5 9 with 6 4 with 7 3 with 8 1 with 9	3 with 5 8 with 6 6 with 7 3 with 8	1 with 4 9 with 5 4 with 7 2 with 8	5 with 5 10 with 6 5 with 7	5 with 5 10 with 6 5 with 7	5 with 5 10 with 6 5 with 7	5 with 5 10 with 6 5 with 7	5 with 4 6 with 5 3 with 6 1 with 7

TABLE 4.—BUD LENGTHS AT VARIOUS DATES—IN INCHES

Week Of

2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13
Average Length Of Buds										
—	3/32	7/32	10/32	16/32	23/32	31/32	1-13/32	1-30/32	3-12/32	4-4/32
		(4/32)	(3/32)	(6/32)	(7/32)	(8/32)	(14/32)	(17/32)	(1-14/32)	(24/32)
Range In Length Of Buds										
	From 2/32 to 4/32	From 4/32 to 10/32	From 8/32 to 12/32	From 12/32 to 22/32	From 18/32 to 28/32	From 20/32 to 1-8/32	From 1-2/32 to 1-18/32	From 1-18/32 to 2-12/32	From 2-24/32 to 4-8/32	From 3-16/32 to 5-16/32

TABLE 5.—HEIGHT AT VARIOUS DATES—IN INCHES

Week Of

2/2	2/9	2/16	2/23	3/2	3/9	3/16	3/23	3/30	4/6	4/13
Average Height										
4-4/8	4-5/8	7-6/8	9-4/8	12-2/8	11-6/8	13-7/8	14-7/8	16-1/8	17-7/8	15-1/8
Range in Height										
From 4 to 5	From 4-3/8 to 6-4/8	From 6-2/8 to 9-4/8	From 7-6/8 to 11	From 11 to 14-2/8	From 10-4/8 to 14-2/8	From 11-6/8 to 16-6/8	From 13-2/8 to 17-4/8	From 14 to 19	From 15-6/8 to 22	From 11 to 19

TABLE 6.—LEAF COUNTS AT VARIOUS DATES

Week Of

2/2	2/9	2/16	2/23	3/2	3/9	3/16 on
Average Number Of Leaves						
21.2	34.6	56.3	64.7	72.4	68.8	74.7
Range In Number Of Leaves						
From 17 to 26	From 26 to 45	From 48 to 64	From 59 to 71	From 59 to 84	From 55 to 84	From 66 to 87

LILY CULTURE AND TIMING FOR EASTER, 1964

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The lily is the traditional flowering plant for Easter and it is important that the complexities in its culture be well understood in order to produce a plant of highest quality for customer satisfaction.

Types of Lilies

For many years the Croft lily has reigned supreme as "the" Easter lily to be grown in pots. Though it grows well, it is subject to root rot and leafscorch which greatly detract from its value as a finished plant because of their devastating effects. There are apparently numerous strains of Croft since bulbs from different sources vary in length and width of leaves. spacing of leaves on the stem, and plant height.

The Ace lily is rapidly overtaking the Croft since it is less subject to leafscorch and root rot. It has a slightly smaller flower and the leaves are shorter so more can be grown on a bench. There are no practical differences in bud count or forcing time between Croft and Ace.

Nellie White resembles Croft except it usually is a little shorter in growth and may have slightly smaller flowers. It often forces a little more rapidly than Croft.

The Georgia lily has been grown as a cut flower type for years since it is dug early and can be forced into flower in January. When grown as a potted plant it was usually too tall. However, Southern-grown Georgia bulbs not precooled. but potted and placed in a cold frame for later forcing in a greenhouse, have shown considerable promise.

The King lily is a West Coast-grown Georgia that does not appear to grow quite as tall as its southern counterpart and has good bud count when handled in the conventional way. As a frame-grown lily, it too shows promise.

Olympia is also a West Coast-grown Georgia.

No. 44 is a tetraploid lily with large flowers. Growth and bud count are similar to Croft though it, too is basically a West Coast-grown Georgia.

Arai is a Japanese-grown selection of Erabu which some florists force in limited quantities as a potted plant.

DeGraaff hybrids are garden lilies that someday may be quite important items for Easter, Mother's Day, or Memorial Day. There are a number of colors available and the plants are hardy making them an attractive item for garden stores. Forcing procedures have not been adequately determined — they grow rapidly and become rather tall, but with storage temperature manipulations and growth inhibitors. these types could be a valuable addition to the Easter market.

Fall Handling

West Coast-grown bulbs are generally dug in late September, sorted and graded, packed in cases, and shipped East in refrigerated trucks or railroad cars to commercial storages maintained at 33°F. The bulbs receive at least six weeks of such cold storage to bring about chemical changes within that will enable the florist to force them into flower in approximately 120 days in the mid-west.

As the length of cold storage time increases, bud count goes down, and recent research at several institutions has shown that it may be quite advantageous to hold the bulbs at 65° or 70°F after digging, then give six weeks of cold storage, and ship them to the customer. Bud count is noticeably higher and the leaves at the base of the stem are not so short or skimpy.

The success of frame-grown lilies may in part be due to the initial high temperature followed by a precooling temperture as the fall and early winter season ensue.

Bulb Sizes

The popular forcing size is the 7- to 8-inch which is packed 250 bulbs per case. The number of flowers one may expect from a 7-8 depends upon the cultural practices, but from 3 to 5 flowers would be a general average. The 8- to 9-inch size, packed 200 per case, may average 4 to 7 flowers depending upon the forcing practices, and the 9- to 10-inch, packed 150 per case, and the 10- to 11-inch, 100 per case, are used where very high bud count is wanted.

Not to be overlooked is the 6½- to 7-inch bulb which can produce a surprisingly good lily under favorable culture. They may be as satisfactory as the 7-8 bulbs for a florist who can do a good job of growing lilies. Some of the Southern-grown lilies never produce large bulbs, but still have high bud count when forced, particularly if frame-grown.

For larger specimens, several bulbs may be placed in a pot initially or the finished plants can be knocked out of their pots and combined in a larger pot.

Sprouting

Sometimes the environmental conditions on the West Coast cause growth of the stem in the field during the summer. This stem normally is dormant until the bulb is dug, cooled, and then forced. Should sprouted bulbs be received, do not break off the shoots since this will eliminate the Easter flowers. The bulb should be potted as low as possible to bury the sprout and if it protrudes above the soil, protect it from sunlight for a week or so with newspapers, etc., until it turns green. Sprouted bulbs generally flower earlier than unsprouted, because the stem has started to grow before potting. Bud count is generally not affected by sprouting unless the shoots are six or more inches long.

Time of Potting

Lily bulbs are usually shipped to the forcer from mid-November on depending upon the date of Easter. Usually 120 days or 17 weeks are allowed for forcing in the mid-west, so the bulb shippers will send them to arrive about this time. Since Easter is quite early, March 29, bulbs will arrive in late November for potting. Should the bulbs arrive somewhat before the scheduled potting date, keep them in cold storage, 32° to 50°F, rather than at temperatures above 50°F, since this can cause a partial reversion of the precooling and delay flowering.

Leafscorch

Croft lilies are highly subject to leafscorch which is characterized by the appearance of half-moon shaped brown areas near but not at the top of the leaves, usually first appearing at the mid-portion of the plant. One or more such areas may develop and on severely affected plants, the leaves may appear as if burned with a blow torch. Ace is also subject to this trouble, but to a much lesser extent.

It has been known for some time that maintenance of a high pH (6.5 to 8.0), a high nitrogen and low phosphorus level in the soil would reduce or eliminate leafscorch, though why these were effective was not understood. Syringing the plants was found to minimize the trouble which lead to the assumption that some material within the plant may be exuded, causing the brown areas. Research at Alabama has indicated that the mineral element lithium is the cause of leafscorch. Though not a fertilizer material, this element is absorbed by the plant and evidently accumulates near the leaf tips where it causes the "burning." Lithium is found in soil and may be in some fertilizer in minute amounts as an impurity, so there is little that the grower can do other than maintain the soil pH, nitrogen, and phosphorus levels in a favorable range which apparently minimizes the absorption of lithium or its detrimental effect when within the plant.

Plants with roots injured by overfertilization, overwatering, or other causes generally shown leafscorch to a greater degree than plants with healthy roots.

Soil

To avoid troubles from root rot due to poorly aerated or poor drained, heavy soil, select soil that does not "run together" or become packed over a period of time. Coarse soil, with lumps, is preferred to that run through a shredder since the latter breaks up the soil into fine granules.

Heavy soils should have coarse additives incorporated to dilute the soil and permit free flow of water out and air in. Coarse sand is useful but additions can be overdone making a mixture that dries quickly, necessitating too frequent watering which may aggravate root rot. Fine sand usually packs. making the soil like concrete. Soil with undue amounts of coarse sand added weighs more which can be undesirable. Coarse Perlite may be used in place of sand.

Manure can be added to loosen the soil and coarse peat is also useful. Beware of mucks which break down rapidly and can create a wet soggy condition in the soil.

Steam sterilization is advised to kill undesirable disease organisms. In addition, steaming aggregates the soil making it better drained and aerated.

Addition of lime, limestone, or dolomite at the time of preparation of the soil may prevent later troubles from leafscorch. Incorporation of a 5-inch pot per wheelbarrow (2½ bu.) of either of the above materials to most soils will raise the pH to the desired point, if it is somewhat lower to start with, but the soil should be tested after it is mixed to be sure it is at the desired range.

Because high phosphorus aggravates leafscorch, it is suggested that the time-honored recommendation of the addition of a 4- or 5-inch pot of superphosphate (or bonemeal) per wheelbarrow be omitted unless the soil is extremely low in phosphorus and none is to be added during the forcing period. Should it be considered necessary to add phosphorus to the potting soil. use half the usual amount recommended.

Bulb Dips

Dipping bulbs in fungicides to prevent rot is not worth the trouble when it is realized that the liquid does not easily penetrate the spaces between the scales, and furthermore, as the roots develop. they grow away from the protective fungicide.

Potting

To promote drainage of water from the pot itself, place a handful of gravel in the bottom or use the plastic Aero-drains.

The nose of the bulb should be placed 2 inches below the surface of the soil (allow for settling). This will permit stem roots to develop which help anchor the plant and serve as an additional root system should the roots from the basal plate be injured or killed by faulty cultural practices.

Depth of planting influences timing! Bulbs planted very shallowly (half or more exposed) will flower earlier than bulbs planted deeper. Those planted on the bottom of the pot, then covered with soil almost to the pot rim, will be the last to flower, although usually not undesirably so.

Sprouted bulbs should be planted deeply to hide the bare stem and keep the overall plant height within bounds.

Watering

The initial watering after potting should be thorough to wet the entire soil mass. Subsequently, however, the frequency of watering should be such that the soil becomes rather dry and this is particularly important in the early stages as the roots and tops are beginning to develop. As the plant grows and becomes larger, coupled with increasing light intensity and temperature, the frequency of watering will be increased.

In the early stages, the soil can become quite dry on top and still be adequately moist in the area where the roots are developing since the root system will not be large enough to absorb quantities of water. A well-drained soil will minimize trouble from "wet feet" which is usually disastrous to the lily. Use common sense in watering!

Plants with rotted or injured roots should be placed together where they can be carefully inspected and watered individually as needed. To encourage new root development when the root system has been injured, knock the plant out of the pot, re-arrange the drainge material, place the pot over the ball and set the pot down **lightly** on the bench so there is a column of air between the pot wall and soil ball. This, together with intelligent watering, can prevent undue losses of plants from poor roots.

Flower Buds

Easter lilies form flower buds when the shoot is 2 to 4 inches above the nose of the bulb. The amount of food within the bulb probably governs the number of buds that **initiate** or **form** since small bulbs have fewer flowers than larger bulbs. The **development** of the buds that initiate is controlled by the cultural practices of the florist, and improper culture can reduce the bud count considerably. A presentation of these important factors follows.

Fertilization

When the shoots are first visible above the soil it is time to begin fertilizing since adequate nitrogen will maintain good green foliage color and no doubt contributes to maintenance of good bud count. Special analysis fertilizers high in nitrogen, low in phosphorus, and medium in potassium are available which can be used at 1 oz. per 3 or 4 gallons every 2 weeks.

Sodium nitrate or calcium nitrate at 1 oz. per 3 gal. together with muriate of potash at ½ oz. per the same 3 gal. can be applied every 2 weeks.

For injection, a complete fertilizer low in phosphorus can be used at 1 oz. per 15 gal. For a 1-100 injector this is 20 lb., 12 oz. per a 50-gal. barrel and double this amount for a 1-200 injector. For florists who are using 200 ppm each of nitrogen and potassium in their injectors, it is suggested that no phosphorus be injected during the time the lilies are being grown because of the dangers of leafscorch. For a 1-100 injector the combination of 37 lb., 8 oz. of calcium nitrate or sodium nitrate and 18 lb., 12 oz. of potassium nitrate in a 50-gal barrel will provide 200 ppm each of nitrogen and potassium, and a portable unit may be desirable where a wide variety of crops are grown.

Nitrogenous fertilizers in the form of ammonium compounds (ammonium sulfate, ammonium nitrate, and ammonium phosphate) are acid in their final reaction in the soil and as such can cause a gradual drop in pH so leafscorch could be a problem. The high analysis complete fertilizers to be applied in liquid form generally have one or more of these materials, and should they be used to fertilize lilies, a periodic check should be made on the soil pH. Should the pH drop below 6.5, the use of limewater is suggested. Place ½ lb. of hydrated lime (not limestone) in 100 gal. of water, stir to dissolve the material, let settle, and then apply the clear solution to the soil in place of a watering. The soil should be somewhat more moist than usual at the time of limewater application to avoid root injury. If the agitated limewater solution is applied, the undissolved lime particles will act as a layer of cement on the soil surface and may seal it.

Plants with injured or dead roots should not be fertilized, but instead segregated where they can receive individual attention.

There is no basis for the oft held belief that fertilization causes lilies to stretch.

Light Intensity

Light intensity is an important factor governing the number of flower buds that develop. Bud count is reduced if plants are shaded by a gutter, adjoining buildings, dirty glass, and the like.

Lilies may have to be turned 180 degrees in order to have straight stems since they often will lean south. Turning may be necessary several times during the growing season.

Where the lilies are of the proper height, the tallest plants can be placed on the north side of a bench running east and west with the shortest plants on the south side. In this way no plants shade the top of the plant to the north. If the lilies are short, put the tallest plants on the south side of an east to west bench, and the shortest plants on the north side. There will be a slight reduction of light intensity which will cause a moderate increase in stem length of the shorter plants.

Additional Light

Because Easter is early (March 29) there is a distinct possibility that some growers will discover their plants are behind schedule. A rule of thumb is that buds should be visible in the leaf cluster 6 weeks before Easter when grown at 60°F. At this stage they are usually about ¾ to 1 inch long. Eight weeks prior to Easter the buds will be only about ¼ inch long at 60°F, and this is as early as one can determine timing based on bud size.

Lighting raises the leaf temperature and this probably has more to do with increasing the speed of growth than any extra photosynthesis that may occur since the light intensities used are so low. Warming the plants by means of lighting may be cheaper than raising the temperature which will also hasten development. The use of supplementary or additional light will cause the lilies to become tall or even somewhat spindly since the far-red radiation (not quite infra-red) from lamps increases the elongation of the cells in the plants and consequently the internodes are longer.

Should the plants be behind schedule, the supplementary illumination should be started no less than 6 weeks before Easter, preferably earlier than this, in order to be effective. Use 100-watt bulbs, 4 feet apart, 2 feet above the tops of the plants, and allow them to operate 4 hours or more. The lights can be left on all night if the plants are quite far behind.

Shortening the Day

Providing a short day by means of black cloth shade placed over the plants at 5 p.m. and removed the following day at 8 a.m. will reduce the ultimate height of lilies somewhat. The effect is not very great, and the shading must be started early—around December or early January—or it will have almost no effect. Tall lilies have not been a problem with majority of growers, and it is likely that growth regulators would probably be as effective, and cheaper.

Temperature and Timing

Since Easter is early, the starting night temperature should be 60°F and this temperature should be maintained throughout the growing season. Although height is a rather poor indication of relative maturity, it is a little better than nothing, so the short plants should be moved to higher temperature (65°F) and the tall plants to a cooler house (55° to 58°F) This should be done when the average shoot length is about 4 inches. Continued moving of plants based on height should be done until bud size can be evaluated, then this should be used as a criterion.

At 60°F, the buds should be ¾ to 1 inch long or just visible in the leaf cluster 6 weeks before Easter. Two weeks before Easter the most advanced buds should be bent over at right angles to the stem and they will be from 3 to 5 inches long. In the white "puffy" stage only about 3 days are needed for full development in sunny weather.

Night temperatures can be kept at 70°F if it is necessary to force plants into flower and this should be started at least a month or so before Easter so the plants can be "hardened off" by exposure to a cooler temperature (58°F) before sale. At 70°F or higher, atmospheric humidity should be maintained by periodic syringing or the buds may dry up or blast. This high temperature will materially reduce the substance of the plant and flower and it will be "soft."

Variations in night temperature—60°, then 56°, then 62°, etc.—night after night are said to be the cause of splitting, but it has not been possible to induce this experimentally.

Many florists believe that Ace forces more slowly than Croft, but repeated experimental work has not shown this to be the case.

As has been indicated, height is a rather unreliable index of maturity or stage of development of lilies. This should be evident by the fact that some growers consistently have tall lilies while other growers almost always have short plants. regardless of source. It is very likely that subtle differences in light intensity causes these height variations—reduced light intensity caused by dirty glass. a partition. etc.. is responsible for taller plants.

Pests

Aphids are no doubt the most troublesome insect. Suggested control measures are Lindane, Malathion, Meta-Systox-R. OMPA, Systox, TEPP, Thiodan, or Zectran sprays; Parathion bomb spray or dust; Dithio or Vapona bomb; or Vapona, Dibrom 8, or Lindane vaporized from steam pipes.

Growth Regulators

Considerable research on the use of growth regulators on lilies has been done at the United States Department of Agriculture. Neither B-Nine nor Cycocel are effective in reducing height of lilies. Phosfon D or L may be used, but causes extremely weak stems, particularly if an overdose is applied. Since Ace or Croft lilies seldom become too tall, Phosfon treatment should not be necessary. Georgia lilies do grow tall and Phosfon may be used with this type of lily. Place no more than one ounce of either Phosfon D or L in one gallon of water, stir thoroughly, and apply eight fluid ounces of this diluted solution as a soil drench per six inch pot when the Georgia lily is three to four inches tall. Since only eight pots can be treated per gallon, the cost is rather high.

Storing Plants

Should the plants mature rather early, it is possible to store them at 35° to 50°F. The plants should remain in the cool greenhouse until the buds are in the white "puffy" stage, then the soil watered, and the plants taken to a dark 35° to 50°F storage. They can remain there for 10 to 14 days without detrimental effects and can be delivered to the retail outlet where they will open normally. The soil should be allowed to warm before plants are exposed to bright sunlight.

Development of small brown spots on the petals of the flower is caused by the fungus Botrytis. Before putting lilies in the cool storage, clean out debris of all kinds and spray the walls, ceiling, and other surfaces with Terraclor at 1 lb. per 100 gallons.

Keeping the plants in a cold greenhouse is somewhat of a delusion. When the sun shines it warms the plant, metabolic activity occurs, and ripening proceeds more rapidly than is commonly believed.

Customer Satisfaction

All efforts of the florist in producing a good lily will go for naught if the plant is not properly handled when it reaches the retail outlet and ultimately the customer.

In many retail stores extra help is hired at Easter so they may not be familiar with the cultural requirements and are a poor source of information for the purchaser. Since many lilies are sold at "non-florist" outlets, personnel at such places often know less about the plants than the customer and obviously will be of little, if any, help.

The solution to this dilemma consists of the grower putting "care cards" on the plants before they leave the greenhouse. An extra expense? Yes, but the best insurance that can be provided so people will enjoy Easter lilies to their fullest and continue to buy them year after year.

HIGH TEMPERATURE TREATMENT OF EASTER LILY BULBS

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Lilium longiflorum clones to be forced as Easter pot plants are most often grown in the Pacific northwest and harvested in late September and early October. It has commonly been thought that digging should be delayed as long as possible since the presence of green foliage even in October indicated that economic increases in bulb size would result. Under present commercial conditions, however, the digging operation must be completed in such time as to allow replanting of young stock before fall rains. The date of digging, then, is relatively fixed, near October 1-10 for Ace and somewhat earlier for Croft. There is some evidence to indicate that good forcing qualities can be obtained in bulbs dug after mid-September or even earlier although, much research remains before this is proven or disproven.

The date of Easter, fluctuates over a 35-day period from March 21 to April 25. Thus in years with the earliest Easter dates the period from digging to flowering accommodates the 6-week cold (vernalization) period usually deemed necessary, and the 120-day forcing period usually allowed with only 7 or more days allowed for delivery from bulb field to cold storage facility if an October 5 digging date is assumed, Table 1. Later Easters, however, allow up to 6 weeks additional time for storage or forcing. Since greenhouse space is more valuable than storage space, bulbs are generally relegated to low temperature storage for up to 6 weeks longer than that thought required.

Many investigators have presented data similar to that in Tables 2 and 3 showing the deleterious effect of prolonged cold treatment. While the number of days to flower further decreases with increased exposure to vernalizing temperatures, Tables 2 and 3 give data showing that rapidity of flowering is associated with a serious decrease in the number of flowers. In addition, lower foliage becomes shortened and sparse. In addition to cold temperatures in storage, bulbs are exposed to additional natural vernalization in the field, in some years, which may further contribute to a decline in quality.

It would appear desirable to in some way prevent these undesirable effects. The method of coldframe storage used in pacific coast areas and recently receiving more attention in the east is one approach to solving this problem. Coldframe treatment has resulted in greater numbers of flowers than the now standard 33°F vernalization in peat moss, especially after the minimum length of time for vernalization to occur, Table 3. Such treatment has also resulted in more dense attractive lower foliage.

Table 1. Dates of early, mid, and late Easters with associated potting dates, vernalization dates, and number of days from an October 5 digging to the vernalization date.

Easter Dates	Potting Date, 17 weeks (119 days) prior to flowering	Start vernalization, 6 weeks prior to potting	Days from Oct. 5 digging to start of vernalization
Earliest Easter March 21	November 23	October 12	7
Mid Easter April 7	November 10	October 29	24
Latest Easter April 25	December 28	November 16	42

Table 2. Effect of time and temperature of vernalization on the number of flowers and days to flower for Ace lilies. Each value is the mean of 180 plants. Wooster, Ohio. 1960-61.

	Vernalization Temperature							
	31°F		41°F		51°F		Average	
Weeks Treated	Number of flowers	Days to flower	Number of flowers	Days to flower	Number of flowers	Days to flower	Number of flowers	Days to flower
0	10.2	233	10.2	233	10.2	233	10.2	233
1	9.7	200	10.7	199	9.5	220	9.8	207
2	9.1	177	9.1	161	9.4	198	9.1	179
3	8.4	155	6.3	130	9.7	178	8.1	155
4	8.8	161	5.9	121	9.1	128	7.9	148
5	5.5	116	5.4	116	7.5	146	6.1	127
6	7.1	138	5.4	114	7.2	152	6.6	135
7	4.8	110	4.1	107	6.3	133	5.1	117
8	4.3	109	3.7	105	5.8	127	4.6	118
9	6.2	121	3.1	104	4.7	119	4.6	115

Table 3. Effect of time and type of vernalization on the number of flowers and days to flower for Ace lilies. Each value is the average of 20 plants. Wooster, Ohio. 1959-1960.

	33^{o}F Vernalization, case		Frame Vernalization, potted	
Treated	Number of flowers	Days to flower	Number of flowers	Days to flower
0	9.1	183	9.1	183
1	8.4	168	7.9	165
2	8.0	159	7.2	156
3	7.5	150	6.9	147
4	6.6	135	6.3	140
5	5.1	134	6.8	134
6	5.2	132	6.1	140
7	4.6	129	5.5	134
8	4.2	127	5.8	129
9	4.8	124	5.7	125
10	3.9	118	5.6	119
11	4.1	116	4.8	114
12	3.2	113	5.4	112

Explanations of the performance of coldframe treated bulbs have largely centered around the fact that rooting can occur prior to rapid stem elongation and the fact that potted bulbs do not loose moisture. Although evidence to the contrary is limited, data by Merritt[1/] shows that holding potted bulbs in 33^{o}F storage is not as advantageous as is holding in a cold greenhouse, a situation similar to a coldframe.

It would appear that the explanation of the superiority of coldframe treated bulbs is not likely related to root growth or drying of the bulb. Stuart[2/] and Blaney and Roberts[3/] pointed out that 2-4 weeks of temperatures near 65-70^{o}F prior to cold storage treatment reduced the loss in flowers associated with long-term

1/ Merritt, Richard H. 1963. Vegetative and floral development of plants resulting from differential precooling of planted Croft lily bulbs. Proc. Amer. Soc. Hort. Sci. 82:517-525.

2/ Stuart, Neil W. 1946. The effect of storage temperature and length of storage on forcing Northwest lilies for easter. Flor. Rev. September 26. 2 pp.

3/ Blaney, L. T. and A. N. Roberts. 1962. Abstracts of papers presented before the Amer. Soc. Hort. Sci. 59th Annual Meeting, Corvallis, Oregon. August 25-29, 1962.

cold treatment. Smith[4/] suggested that results of his work indicated that low temperatures vernalized bulbs and that high temperature prevents vernalization or perhaps could result in non-vernalization. Lattimer[5/], Kiplinger[6/], and Kehl[7/] in three consecutive years, presented data showing that 90°F for as short as 6 days following cold storage resulted in a delay in flowering. An adaptation of their data is presented in Table 4. Generally, the amount of delay increased as the length of time at 90°F increased. It is of interest to note that 70°F either did not delay flowering or promoted it. No detailed information was presented on the method of holding bulbs while at high temperature and this could materially influence results.

While coldframe treatment is one practical solution to the problem of producing high quality lilies, the method is cumbersome for some forcers. Additionally, it does not offer bulb producers and bulb suppliers the opportunity to more exactly control the shipping and forcing qualities of bulbs for an early or late Easter. High temperature treatment (more properly non-vernalizing temperature treatment) would seem to offer many such possibilities.

If Table 1 is considered, it is seen, for example, that a mid Easter falling on April 7 accommodates vernalization time and forcing time with 24 days to spare. A late Easter falling on April 25 accommodates the above requirements with 42 days to spare. If treatment not deleterious to forcing qualities--flowers and foliage--could replace standard 33°F storage for the extra time mentioned, decided benefits would result.

The preliminary experiment reported in detail here was designed to examine possibilities for more exacting growth control by bulb producers, suppliers and greenhouse operators.

More specifically the experiment was designed to determine:

1) Suitable time and temperatures for non-vernalization in the range of 2-4 weeks and 70-90°F.

2) Suitable temperatures for vernalization after non-vernalizing temperature treatment.

3) The effect of partial vernalization interrupted by a period of non-vernalization treatment before final vernalization, a situation likely to be encountered with late digging and a late Easter or after a period of cool temperatures before digging.

4/ Smith, Derek Rodney. 1963. The influence of the environment upon initiation and development in Lilium longiflorum (Thumb.) Cornell University Ph.D. Thesis. 169 pp.

5/ Lattimer, Mary. 1954. 1954 Lily Studies. Ohio Flor. Assn. Bul. 303:4.

6/ Kiplinger, D. C. 1955. 1955 Lily investigations. Ohio Flor. Assn. Bul. 315:4.

7/ Kehl, Wesley. 1957. 1956 Lily investigations. Ohio Flor. Assn. Bul. 331:2.

Table 4. Effect of various temperatures following cold storage before planting on the number of days to flower and the number of flowers of Croft lilies. Figures in the "days" columns refer to the number of days later or earlier (-) that flowering occurred as compared to bulbs held at 32-33°F.

Data by Lattimer, Kiplinger, and Kehl
Columbus, Ohio. 1954, 1955, 1956.

Temperature after cold storage, before planting, °F.	Number of days at temperature before planting. 3		5		6		9		10		15		21		35	
	Days	Flrs.	Days	Flrs.	Days	Flrs.	Days	Flrs.	Days	Flrs.	Days	Flrs.	Days	Flrs.	Days	Flrs.
32-33	0	3.5	0	9	0	3.8	0	3.4	0	6	0	6	0	6	0	4
45	-4	3.1	1	6	-7	3.6	-9	3.5	-1	5	--	--	-1	5	-9	4
70	-7	2.9	1	5	-2	3.1	0	3.2	-2	5	2	5	-5	3	-15	2
90	1	2.8	14	5	8	2.6	20	2.8	20	4	16	6	39	5	44	5

Methods: Bulbs were 7-8" Ace lilies obtained from 9 producers[1/] in the Smith River, California area. Bulbs from 5 growers were received October 23 having been dug October 4-7, packed October 5-9, and shipped via refrigerated truck October 16 to Chicago and thense to Wooster, Ohio, via railway express. Bulbs were unpacked and divided into 17 equal groups of 15 bulbs each, representing 3 bulbs from each producer. Each of the 17 groups was then repacked in air dry peat (32% moisture) in polyethylene bags and placed at 33°F immediately.

Bulbs from a second group of 4 producers were received November 8 having been dug October 16-18, packed October 18-22 and shipped via refrigerated truck and railway express date unknown. Table 5 shows temperatures recorded from packing until temperature treatment as recorded by a thermograph packed in the center of one case. Bulbs were unpacked and divided into 17 equal groups of 15 bulbs each representing 3 bulbs from 3 sources and 6 from one source. Each of the 17 groups was then repacked in air dry peat (24% moisture) in polyethylene bags and distributed along with the 17 groups from the first shipment, to the temperature treatments.

Temperature treatments of 70, 80, or 90°F were given for a period of 2 or 4 weeks. Following high temperature treatment, bulbs were vernalized for a period of 4 weeks at 33°F, 40°F or a combination of 2 weeks of 40°F followed by 2 weeks of 33°F. Bulbs receiving 2 weeks of high temperatures were potted December 21, 17 weeks prior to April 12, and those receiving 4 weeks of high temperatures were potted January 4, 17 weeks prior to May 3. In addition, bulbs were maintained at 33 and 40°F but due to an error, all combinations of time and temperature for vernalization were not included.

Table 5. Packing case temperatures representing the second shipment of bulbs packed at Smith River, California, October 21 and opened at Wooster, Ohio, November 8, 1963. Shipment via refrigerated truck to Chicago, Illinois, then via railway express.

Date	Average temperature	Date	Average temperature	Date	Average temperature
Oct. 21	55°F	Oct. 27	58°F	Nov. 2	47°F
Oct. 22	56	Oct. 28	58	Nov. 3	47
Oct. 23	57	Oct. 29	58	Nov. 4	47
Oct. 24	57	Oct. 30	56	Nov. 5	45
Oct. 25	58	Oct. 31	52	Nov. 6	45
Oct. 26	58	Nov. 6	48	Nov. 7	43

1/ The assistance of Messers Anderson, Borough, Dahlstrom, Hastings, Lee, Lovenborg, Oliver, Stanhurst, Struebing, Watt, and Westbrook in providing bulbs for this experiment is acknowledged. The cooperation of Mr. Ed. Markham, Vaughan Seed Co., is gratefully acknowledged for assembling and arranging bulbs for shipment.

Following temperature treatment, bulbs were potted in a uniform soil medium. Each lot of 15 bulbs was then divided into two groups of 7 each, discarding one bulb, and each lot of 7 bulbs was placed at random in a separate greenhouse maintained at 60°F minimum night temperature and 65°F minimum day temperature. All plants were irrigated with a pot watering system and were fertilized with a high analysis soluble fertilizer each week. Growth was vigorous and all plants at flowering were of excellent quality except those bulbs vernalized at 33°F for 17 days prior to 90°F non-vernalization treatment which failed to grow.

Results: Treatment at 70, 80, or 90°F for 4 weeks prior to final vernalization resulted in lilies with as large or larger numbers of flowers than 33 or 40°F bulbs, Table 6 and 7. Plants not receiving the 17-day treatment at 33°F, Table 6, and potted January 4 produced more flowers when vernalized at 33°F rather than 40°F. Plants which received 33°F vernalization for 17 days, Table 7, produced much greater numbers of flowers after vernalization at 40°F than did other plants. No explanation of this phenomenon is offered at this time. The number of flowers was slightly greater in some instances after vernalization with a combination of 33 and 40°F vernalization than with 33 or 40°F separately. The differences while not appearing great enough to warrant special attention in this experiment are coupled, in some cases, with large differences in forcing time. Further work must be done with 40°F - 33°F combination.

It is of special interest that plants having the greatest numbers of flowers and held at 70 and 80°F for 4 weeks and vernalized at 40°F flowered in 124 and 122 days, respectively, Table 7. It is true that warmer temperatures prevailed in late April and early May than would normally occur in April. There is, however, a significant indication that the deleterious effects of long-term low temperature storage can be avoided by maintaining bulbs at non-vernalizing temperatures until 4-6 weeks prior to the potting date at which time vernalization treatment could be given. Plants with more flowers, better lower foliage, and rapid growth rate resulted. The type of plant resulting from high temperature treatment compared favorably with plants produced by coldframe treatment.

Most data indicate that primary consideration should be given to 70°F as a non-vernalizing temperature. Although 80°F produced similar results, 70°F is more practically attainable and problems of excessive drying would be greater at 80°F. Future experiments must yield further information on this subject, however, since the days to flower were influenced by non-vernalization temperature.

While the data presented for bulbs potted January 4 tend to strongly support the non-vernalization-vernalization theory previously advanced, an important and presently unexplanable trend was observed. Evidence of non-vernalization by 2 weeks of high temperatures is lacking (bulbs potted December 21). Perhaps the history of temperature treatment prior to receipt of the bulbs was not erased by as short a period as 2 weeks of non-vernalizing temperatures. This is supported in part by the fact that in 4 of 6 cases 40°F vernalization resulted in fewer flowers than 33° or 40-33°F vernalization and by data by Lattimer, Kiplinger, and Kehl.

Discussion: It would appear that temperatures of 70°F and above do have the effect of preventing vernalization of lily bulbs and may even, if given for a sufficient time, erase previous vernalization. This would seem to offer a means of holding bulbs for late Easters and possibly standardize dormancy conditions each year. Extensive experiments are planned to more exactly determine non-vernalizing temperatures and to determine the effects of various lengths of time at such temperatures.

Table 6. Effect of 70, 80, and 90°F non-vernalizing temperatures followed by 33 and 40°F vernalizing temperatures on the number of flowers and number of days to flower for Ace lilies. Bulbs were placed in 70, 80, or 90°F non-vernalizing temperatures immediately on receipt November 8. Wooster, Ohio. 1962-1963.

Non-vernalizing temperature	Vernalization temperature	High temperature 2 weeks potted Dec. 21		High temperature 4 weeks potted Jan. 4	
		Number Flowers	Days to Flower	Number Flowers	Days to Flower
70	33 4 weeks	5.0	118	6.6	120
70	40 4 weeks	3.8	113	6.2	119
70	40 2 weeks, 33 2 weeks	5.6	116	1/	1/
80	33 4 weeks	5.8	121	7.6	128
80	40 4 weeks	5.9	122	6.7	120
80	40 2 weeks, 33 2 weeks	5.1	122	1/	1/
90	33 4 weeks	4.3	120	7.3	131
90	40 4 weeks	4.1	113	5.3	119
90	40 2 weeks, 33 2 weeks	5.4	121	1/	1/
--	33 6 weeks	4.4	111	1/	1/
--	40 8 weeks	1/	1/	3.9	112

1/ Treatments not included.

Table 7. Effect of 70, 80, and 90°F non-vernalizing temperatures followed by 33 and 40°F vernalizing temperatures on the number of flowers and number of days to flower for Ace lilies. Bulbs were vernalized at 33°F for 17 days prior to non-vernalization treatments begun November 8. Wooster, Ohio. 1962-1963.

Non-vernalizing temperature	Vernalization temperature, °F	High temperature 2 weeks potted Dec. 21		High temperature 4 weeks potted Jan. 4	
		Number Flowers	Days to Flower	Number Flowers	Days to Flower
70	33 4 weeks	6.0	137	5.0	148
70	40 4 weeks	4.9	115	9.1	124
70	40 2 weeks, 33 2 weeks	5.1	123	1/	1/
80	33 4 weeks	5.7	120	5.4	144
80	40 4 weeks	5.9	120	8.0	122
80	40 2 weeks, 33 2 weeks	5.4	138	1/	1/
90	33 4 weeks	5.8	121	**2/	**2/
90	40 4 weeks	4.1	150	7.1	120
90	40 2 weeks 33 2 weeks	6.3	115	1/	1/
--	33 8 weeks	5.4	107	--	--
--	40 10 weeks	1/	1/	5.6	100

1/ Treatments not included.

2/ Data missing.

Past work points to most rapid vernalization at temperatures near 40°F. Time for vernalization, however, is more difficult to determine. It is quite possible that little or no work has been published concerning fully "dormant" or non-vernalized bulbs from West Coast areas. Vernalization occurs in the field as pointed out by Blaney and Roberts and the amount of this "natural" vernalization varies from year to year. This is indicated by the fact that in 1959-60 Ace lilies required 9-10 weeks of vernalization at 33°F while only 5-7 weeks were needed at 31°F in 1960-61 for forcing in approximately 17 weeks. With this in mind it would be predicted that the degree of "dormancy" or non-vernalization could materially affect the amount of time necessary for vernalization.

Summary: Experiments to date have shown that the deleterious effects of long-term storage at vernalization temperatures can be prevented.

1. The method of coldframe storage of potted bulbs resulted in lilies with more flowers and more dense, attractive foliage.
2. Non-vernalization of bulbs at temperatures of 70°F or above resulted in lilies similar to those previously produced by the coldframe method.
3. It is suggested that non-vernalization treatment at temperatures near 70°F followed by vernalization at proper temperatures and lengths of time may substitute for long-term vernalization presently used, especially in the case of a late Easter.
4. Much more research on these points is needed. Packing methods, especially, should receive thorough attention.

AN INVESTIGATION OF CAUSES OF VARIATION IN THE GROWTH OF COMMERCIAL AND EXPERIMENTAL LILIES

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Numerous growers and research workers have long noted variations in the growth of lilies treated in a similar way. Different lots of lilies growing in the same greenhouse or the same lot of lilies growing in different greenhouses may bear little resemblance to one another. One grower may consistently produce short plants while another nearby may consistently produce taller plants from the same lot of bulbs. The reasons for such variations have long been in doubt. Various explanations--mostly speculative--have been offered. The source of bulbs, greenhouse orientation and location, variations within individual greenhouses, and many other reasons have been discussed.

Considerable confusion has arisen in the past concerning the results of much lily research because of possible variation in experimental material. No doubt natural variations between seasons and methods of handling bulbs from digging until bulbs reach experimenters have contributed to this problem. The magnitude of variation to be expected from producer, greenhouse, location within greenhouse, and bulb is largely unknown yet it can be assessed. Proper evaluation of both commercial and experimental planting requires more definite information about this possible variation.

For the above reasons extensive plantings were made in 1962-63 to determine the effect of several variables likely to be important in affecting uniformity. These results should be of interest to both growers and researchers. It is believed that information of this kind can make experiments more meaningful though not necessarily more expensive. The techniques used assure maximum information at minimum cost. For the commercial grower, this information should be useful in interpreting variation in their own greenhouses.

The specific objectives of this experiment were:

1. To determine the variation to be expected from bulbs from the same producer.

2. To determine the variation to be expected from different locations in the same greenhouse.

3. To determine if greenhouses maintained at the same temperature affect the above characteristics and to determine the relative effect of variations between greenhouses.

4. To determine the degree of variation in the above characteristics to be expected from bulbs from various producers.

Methods: Bulbs were 7-8" Ace lilies obtained from 9 producers in the Smith River, California area. Bulbs from 5 producers were received October 23 having been dug October 4-7, packed October 5-9, and shipped via refrigerated truck October 16 to Chicago, Illinois then via railway express to Wooster, Ohio. Upon receipt, bulbs were unpacked, peat moss moisture measured, and repacked in air dry peat moss (32% moisture) in polyethylene bags and placed at 33°F immediately. Bulbs from a second group of 4 producers were received November 8 having been dug October 16-18, packed October 18-22 and shipped via refrigerated truck and railway express, date unknown.

Bulbs were unpacked, peat moss moisture measured, and repacked in air dry peat moss (24% moisture) in polyethylene bags and placed at 33°F.

Bulbs were potted December 17 after 8 and $5\frac{1}{2}$ weeks at 33°F for the first and second shipments, respectively. Individual bulb weights were obtained at this time. A uniform soil mixture was used for all bulbs and uniform watering was accomplished with an automatic watering system. Soluble complete fertilizers were applied each week.

Bulbs were distributed to each of 4 automatically heated and ventilated greenhouses (House 6 B had hand operated ventilators) in 6 random locations per greenhouse. In each location 6 bulbs from each of the 9 growers were located at random. There were 36 bulbs from each grower in each greenhouse with a total of 144 in the 4 greenhouses. (See Figure 1.)

The date of flowering was taken when the first flower opened. The number of flowers included all flowers and buds not aborted (abortion was a rare occurrence). Height was measured from pot rim to the base of the lower most flower pedicel. Width was taken as the widest natural lateral spread of the leaves.

Data were statistically treated by analysis of variance and components of variation due to grower, greenhouse, location, bulbs, and interactions were determined. Components of variation and various combinations of numbers of growers, greenhouses, locations, and bulbs were evaluated according to the model below[1].

Producers	$\sigma^2 b(lp)(g)$	$+ b\sigma^2 lp(g)$	$+ bl\sigma^2 pg + blg\sigma^2 p$
Greenhouse	"	"	$+ bp\sigma^2 l(g) + blp\sigma^2 g$
Producers x Greenhouse	"	"	$+ bl\sigma^2 pg$
Location within Greenhouse	"	"	$+ bp\sigma^2 l(g)$
Bulbs/Location x Producers/Greenhouse	"		

The variances of treatment mean for any combination is estimated by:

$$V\bar{x} \quad \frac{\sigma^2 b(lp)(g) + b\sigma^2 lp(g) + bl\sigma^2 pg + blg\sigma^2 p + blp\sigma^2 g + bp\sigma^2 l(g)}{blgp}$$

Where σ_i^2 = component

b = number of bulbs / l x plg

l = " " locations per source / g

p = " " sources per location / g

g = " " greenhouses

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[1] Shultz, E. F. 1955. Rules of thumb for determining expectations of mean squares in analysis of variance. Biometrics 11 (2):123-135.

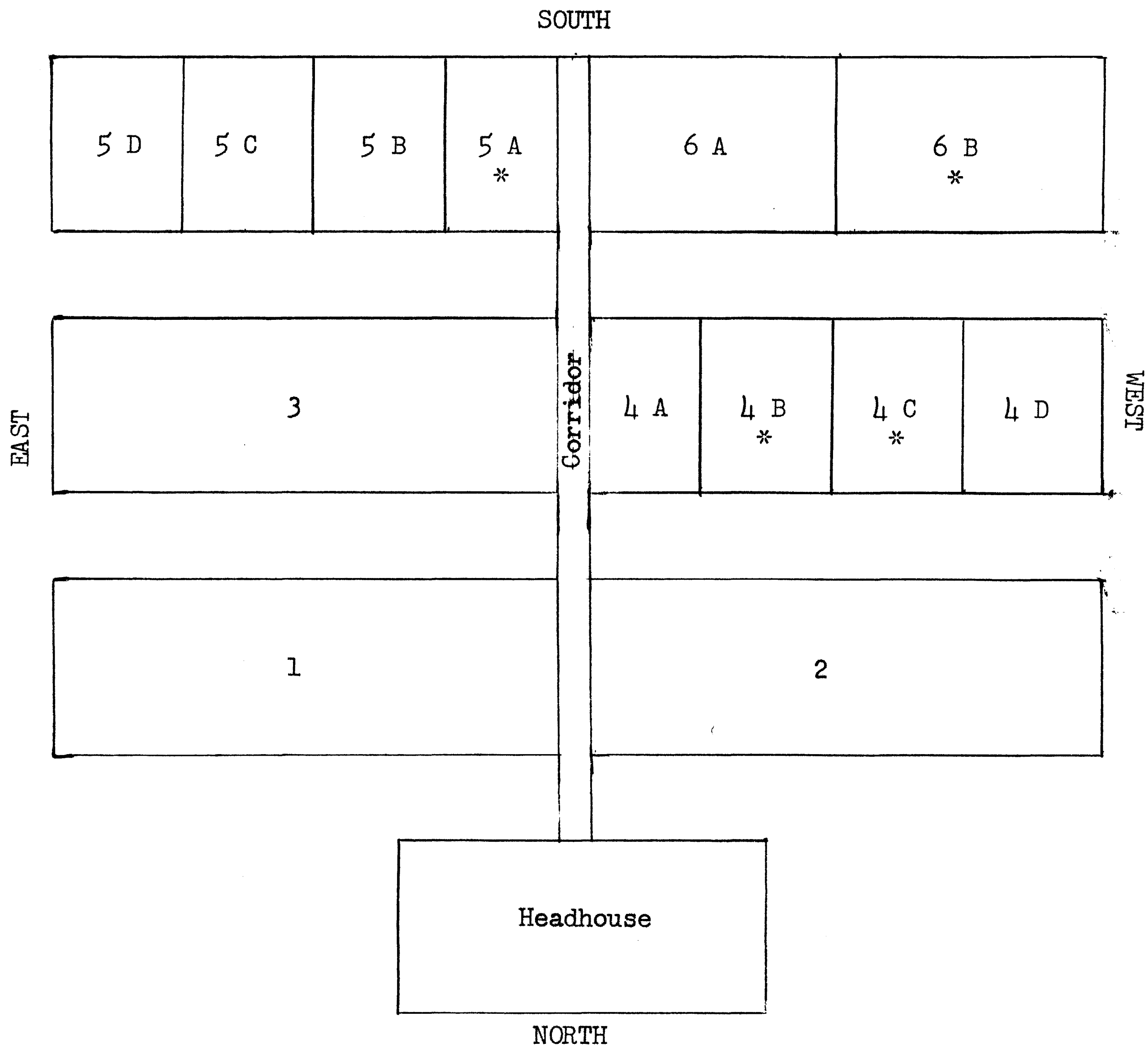

Figure 1. Arrangement of the Horticulture Research Greenhouses at the Ohio Agricultural Experiment Station, Wooster, Ohio. Asterisks indicate greenhouses used for uniformity trials.

Correlations of initial bulb weight with days to flower, number of flowers, height, width, and sprouts at potting were determined as was a correlation of peat moss moisture in the original case and sprouting.

Results: Because of weather conditions in northern California original plans to dig bulbs from all 9 producers as near October 5 as possible could not be followed, thus 2 shipments were received. Because of this delay the moisture content of the supposedly air dry peat moss decreased from 32 percent moisture to 24 percent moisture introducing an additional variable.

Apparently because of the failure of the bags to allow adequate exchange of air, evidence of anaerobic respiration was noted in all three bags containing bulbs from one producer, in two bags from another producer, and in one bag from still a third producer. Bulbs from these bags were retarded in sprouting or did not sprout when the experiment was terminated in May. For this reason data from bulbs supplied by 3 producers were not included. Based upon present knowledge, there is no way to relate this problem directly to the producer. The method employed in handling after receipt of the bulbs was apparently responsible. No evidence of anaerobic respiration was detected in other bulbs, and it was assumed that data for the other 6 producers are valid.

During the time arrangements were being made for bulbs from various producers, it was stressed that no special bulbs should be selected for this trial and assurances were given that identity of producers would be held in confidence. Initial bulb weights reflected considerable differences between growers, Table 7, and correlations of bulb weight were significantly (1 percent level) related to a number of other characteristics, Table 8. The number of days to flower and the amount of sprouting decreased as bulb weight increased. Numbers of flowers, height, and width increased as bulb weight increased. It must be pointed out, however, that such correlations while valid do not necessarily reflect large practical differences as can be seen in Table 7.

Peat moss moisture in the original packing cases was not correlated with sprouting at potting nor was it related to sprouting on arrival. It must be remembered, however, that bulbs were removed from the original cases and repacked in air dry peat moss. Table 9 gives the range in the percentage water in peat moss in the original packing cases.

Table 7. Initial bulb weight, days to flower, number of flowers, height, sprouting and foliage width of Ace lilies obtained from 6 producers in the Smith River, California area. Each figure the average of 144 bulbs.

Producer	Initial bulb weight grams	Days to flower	Number of flowers	Height inches	Sprout index 1=no sprouts 2=all sprouts	Foliage width inches
A	99.9	123	5.5	14.6	1.00	13.2
B	97.0	121	4.3	14.5	1.00	11.8
C	87.2	117	4.9	14.0	1.37	13.1
D	108.0	115	5.4	14.1	1.06	12.9
E	82.4	126	5.3	15.0	1.87	12.2
F	106.7	116	5.3	14.8	1.73	12.7

Table 8. Correlations of initial bulb weight with number of days to flower, number of flowers, height, width, and sprouted bulbs at potting. Correlation coefficients, r, based on 864 observations. Values of r exceeding .090 indicate significance unless a 1 in 100 sampling error occurred.

Characteristics	r
Initial bulb weight - days to flower	-.128
" " " - number of flowers	.191
" " " - height	.128
" " " - width	.094
" " " - sprouting	-.132

Table 9. Percentage of water expressed as percent oven dry peat moss in the original packing cases. Grower number does not correspond to grower designation in other tables.

Grower	Water as percent oven dry peat moss
1	78.5
2	79.6
3	114.2
4	109.9
5	143.2
6	98.2
7	111.0
8	84.4
9	50.8

Table 10 presents variance components due to the known variables in the experiment. Inspection of these components which may be considered as a reflection of the relative importance of each source of variation shows that the greatest variation in all characteristics resulted from bulb to bulb differences within any producer, greenhouse, location combination with the one exception of sprouts. Of first importance with sprouts and second in importance for other characteristics except height was variation due to source. Height was greatly influenced by greenhouse and this is quite evident in Table 11.

Considerable variation, especially in days to flower, number of flowers, and height resulted from bulbs from various producers performing differently in different greenhouse locations. No explanation can be offered for this observation. In greenhouse 5 B such variation appeared to be attributable to the degree of shading.

Table 10. Variance components (σ_i^2) attributable to producer (P), greenhouse (G) location within greenhouse (L/G) bulbs (B/L x S/G) and interactions for several characteristics of Ace lilies. Values reflect relative variation for a given characteristic.

Source of variation	Initial bulb weight	Days to flower	Number of flowers	Height	Width	Sprouts
Producer	104.763	18.118	.149	0.000	.286	.136
Greenhouse	0.000	1.846	.009	4.411	.258	.000
P x G	1.870 1/	0.000	.118	1.619	.026	.042
Location Within Greenhouse	.240 1/	.273	0.000	0.000	.000	.000
L x P/G	8.121 1/	13.315	.143	.972	.134	.035
Individual Bulbs	125.105	67.995	1.363	5.449	1.151	.042

1/ Reflects random distribution error only

Table 11. Influence of 4 greenhouses maintained at the same temperature on the number of days to flower, number of flowers, height, and width of Ace lilies. Wooster, Ohio. 1963.

Greenhouse 1/ number	Days to flower	Number of flowers	Height, inches	Width, inches
5A	122	5.3	16.9	13.3
6B	118	5.3	11.7	12.0
4B	119	4.8	15.3	12.6
4C	121	5.1	14.1	12.6

1/ See Figure 1 for arrangement of greenhouses

The variance of treatment means using 1, 2, 3, 4, and 5 producers; 1, 2, 3, and 4 greenhouses; 2, 4, and 6 locations; and 1, 6, 11, 16, 21, 26, 31, 36, and 41 bulbs per location was calculated. Limits of detection in 99 out of 100 experiments of a difference in number of flowers of one, a difference in flowering time of 10 days and a difference in height of 4 inches were set. The combination of producer, greenhouse, location, and number of bulbs requiring the least number of bulbs was then selected. It was found that 20 total bulbs from 5 producers, grown in 2 greenhouses with 2 locations per greenhouse and one bulb per location would yield maximum information with the fewest bulbs.

Because of the size of the present experiment, it is felt that meaningful experimental designs, especially in the Wooster location, can be based with confidence on the above information.

From the practical view, data in Tables 7 and 11 are of greatest interest. Table 7 indicates that while differences in the performance of bulbs from different producers certainly exist, they are not of the magnitude to explain observed variation in commercial greenhouses. Visual observation indicated that obviously more than one selection of the so-called Ace clone is available. Considerable variation in leaf width, leaf numbers, and leaf length was evident. Sprouting was definitely attributable to specific producers even though bulbs were repacked immediately upon receipt. Most striking, however, is the degree of uniformity of bulbs from different producers. This is not to say that different suppliers cannot offer bulbs of considerably different potential. It must be remembered that all bulbs in this experiment were handled in a similar way during cold storage as regards to packing and temperatures.

Table 11 indicates that differences between greenhouses held at the same temperature as far as practicable may be considerable as regards to height. This was the single most noticeable difference in the entire experiment. The tallest lilies were produced in the most shaded house, the shortest lilies in the house receiving the most light, and intermediate heights in houses with intermediate light.

This agrees with data by Kiplinger (Ohio Flor. Assn. Bull. 291, Dec. 1953). He found that one layer of green saran increased height by as much as 8 inches. Numbers of flowers were not materially affected nor was the date of flowering except in one case. The number of blasted and split flowers, however, was increased by shading.

APPLYING TERRACLOR WITH OR WITHOUT DEXON

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For crops grown in beds or benches, it has been customary to recommend 1 pound of Terraclor to 800 square feet of ground area. Since many materials applied in liquid form are watered on the soil at the rate of 1 quart per square foot, in order to apply Terraclor at the correct rate only ½ pound of the 75% wettable powder should be placed in 100 gallons of water and the solution should be applied to 400 square feet (4'x 100') which is at the rate of 1 quart of liquid per square foot.

For potted plants, Terraclor should be used at the same amount per square foot, but this is NOT ½ pound per 100 gallons of water. Use only 4 ounces of Terraclor per 100 gallons of water and apply it at the rate of 8 fluid ounces per 6-inch pot which means 100 gallons will treat 1600 6-inch pots. This is a slightly reduced concentration compared to bench- or bed-grown plants, but sufficiently adequate to provide protection from Rhizoctonia if this organism is not already present and causing root rot.

For the 70% Dexon, use 4 ounces per 100 gallons, apply 8 fluid ounces per 6-inch pot, and the 100 gallons will treat 1600 6-inch pots -- the same as above.

For a combination of Dexon (70%) and Terraclor (75%), use 4 ounces of each per the same 100 gallons of water and apply at the rate of 8 fluid ounces per 6-inch pot so 1600 pots will be treated with 100 gallons.

If you have some of the 35-35 Dexon-Terraclor preparation, use 8 ounces of this mixture per 100 gallons of water and apply 8 fluid ounces to a 6-inch pot so the 100 gallons will treat 1600 pots.

Overdoses of Terraclor are suspected to have caused difficulty in the form of injury to the root system of potted plants even though the roots may not necessarily be discolored. If roots are injured, it usually appears in the aerial portions as a failure to develop properly. Since Terraclor is quite persistent in the soil, only 1 application in the life of a potted plant is suggested.

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