

# TEMPERATURE STUDIES OF

# *Lilies*

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A view of a field of Easter lilies in full bloom at Boroughs Farm, Smith River, California. This photograph was taken in early July on a cool and foggy day, which is typical of that bulb-growing region.

**M**ORE THAN 7½ million Easter lily bulbs are produced in coastal northern California and southern Oregon. This figure represents 75% of all the lily bulbs produced in the United States for eventual use as potted plants and cut flowers. In addition to the bulb industry, vast numbers of flowering potted plants are forced by California nurserymen for Easter sales.

## Forcing

Forcing (producing flowers on a rigid schedule) lilies for the Easter market is highly specialized and exacting, since the plants must be brought to flower just before the holiday. Timing is complicated by at least two important variables. First, the date of Easter varies each year from as early as March 21 to as late as April 25, which means growers must vary planting and growing procedures accordingly. A second variable is the weather prevailing in the field when the bulbs are maturing. Unusually cool summers may have an effect on the amount of cold stimulus which bulbs receive and this in turn affects the growth habit of the lilies in the greenhouses when they are forced for Easter.

The necessity for precise timing of this crop has caused considerable effort to be expended investigating factors which influence flowering. Past work has shown that the lily is quantitatively promoted to flower by low temperature. Since the flowers do not actually initiate during the low-temperature period, low temperature is inductive and true vernalization (necessary low-temperature treatment to induce flowering), occurs with exposure to cold. Flowering occurs more rapidly if the newly harvested bulbs are stored from four to six weeks at temperatures between 35° and 40°F. This low temperature is maintained after bulbs have been shipped to distribution points in the East, by placing the packing boxes in commercial refrigeration facilities at about 35°F. For bulbs remaining in West Coast areas, such as San Francisco and Los Angeles, low temperatures are obtained naturally by planting the bulbs in pots in October and placing them out-of-doors until late December.

The quality of pot plants resulting from West Coast handling procedures has been considered superior to that of plants produced by low temperature storage methods used in the East. It is known that too long a period of low temperature storage, or "oververnalization," results in the reduction of flower buds and a

short plant with fewer leaves and small lower leaves (see photo). Previous work has shown that exposures of bulbs to periods of high temperature, prior to low temperature storage, may result in characteristics similar to those of lily bulbs subjected to outdoor chilling treatments. This was related to exposure to high temperatures early in the growth period, followed by minimum exposure to low temperature later or to daily fluctuations of temperature. The most popular explanation for the effect of high temperature is that it keeps the bulb in an inactive stage—which results in less time for storage at low temperature with less chance of "oververnalization."

## Heat treatment

Another possibility, not precluding that just discussed, is that heat treatment also reduces or nullifies any prior accumulation of cold stimulus, or reverses low temperature vernalization.

Reversal of vernalization by heat is known in other plants such as winter rye, henbane, and Canterbury bells. Experiments with lilies to determine if this phenomenon occurred were performed at Los Angeles during 1964-65. In one such experiment, bulbs were alternately, or continuously, exposed for periods of six weeks to temperatures of 40° and 70°F.

Total storage periods were either 6, 12, or 18 weeks. The graph shows that 40°F storage temperatures hastened flowering; and, by comparison, 70°F delayed flowering when both were applied for six weeks. After 12 or 18 weeks of exposure bulbs receiving both 70°F and 40°F temperatures flowered in direct relationship to the temperature to which they were last exposed. Thus, bulbs receiving a total of 12 weeks of storage, but receiving six weeks of 40°F after six weeks of 70°F temperatures, flowered in 122 days. Those receiving 70°F after 40°F flowered in 160 days, even though bulbs exposed to only six weeks of 40°F flowered in 120 days.

### Reversal

Results of this experiment show that a reversal (or nullifying) of vernalization does take place in the lily. Earlier experiments and those at UCLA indicated that not all bulbs responded to the high temperature treatment. It was reasoned that after six weeks of low temperature, the vernalization process could have progressed to the point where it was non-reversible. In order to test this hypothesis, bulbs were stored for one, two, four, and eight weeks at 35°F, prior to exposure to either 68°F or 86°F, for four weeks. After this period of high temperature treatment, all bulbs were held four weeks at 35°F to hasten flowering.

Four weeks of 68°F was adequate to overcome the vernalization of the one-, two-, or four-week periods, but was not effective in devernializing those bulbs exposed for eight weeks at 35°F. The higher temperature (86°F) for four weeks reversed the effect of all the prior vernalization treatments. Since high temperatures were used only for four weeks, it is not possible to determine the exact nature of the time-temperature relationships in the devernialization of the bulbs from the experiments reported. Further work is in progress at this time.

Results of experiments reported here may be of importance in reducing the amount of variation resulting from year-to-year climate differences in the bulb-producing areas. All evidence points to the ability of bulbs to accumulate cold stimulus in the field after the time of flowering, but prior to harvest. Under such conditions, years with particularly cold periods after flowering could result in bulbs having the ability to flower more rapidly in the greenhouse when being forced. When what is considered to be a "normal" amount of low temperature

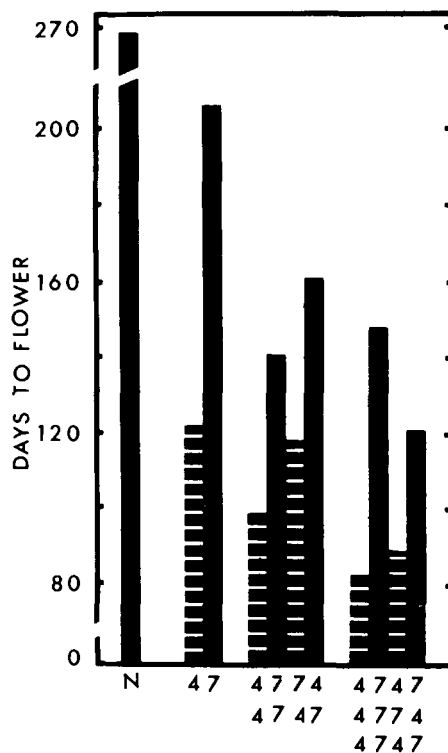
refrigerator storage is then superimposed, bulbs could be "oververnalized." As mentioned before, the results of such "oververnalization" are rapid flowering, reduced numbers of flowers, short lower foliage, and fewer leaves.

There is a distinct possibility of using high temperatures to nullify or reduce field vernalization. Bulbs then could be subjected to a cold treatment to "custom vernalize" them when it is desired. Present data indicate that less physiological change occurs in the bulbs held for periods of up to at least four weeks at 70°F than at any other temperature. Thus, this temperature can be used for newly harvested bulbs as a devernialization treatment, and bulbs can be held at this temperature until it is time to vernalize the bulbs again with the proper low-temperature storage.

Much work remains before commercial trials can be attempted on a scale sufficient to evaluate the year-to-year effects of devernialization. The bulb-packing method is most important. It is now known that the desiccating effect of high temperature storage should be avoided, and, in addition, the problem of excess bulb moisture immediately after packaging must be prevented. Continued research in these areas should also provide answers to practical problems which presently limit the widespread use of promising devernializing treatments.

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Effect of bulb storage at 40°F (4) and 70°F (7) on the time required for flowering of Easter lilies. Solid bars represent those bulbs which were in storage at 70°F (7) just prior to potting, and broken bars represent those bulbs that were in 40°F (4) storage just before planting. Top row of figures indicates bulbs had a total of 6 weeks storage; the second row, 12 weeks storage; and the third row, 18 weeks storage at either constant temperature or alternating temperatures.

Comparison of lily plant (right below), showing the effects of overlong cold storage with one (left) receiving proper vernalization treatment. Plant on left resulted from planting bulb into a pot soon after field harvesting and then placing the plant out-of-doors for natural cooling. Plant to right resulted from storing newly harvested bulbs at 40°F for eight weeks prior to planting in pot. Both plants were brought into the greenhouse in late December and then photographed in April. Note that lily to left has more flowers and longer leaves at base of plant.

