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Forcing Bulbs and Azaleas

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Tulips, hyacinths, daffodils and azaleas will force completely under artificial light. The time required for forcing and the quality is equal to, or better than, comparable material forced in the greenhouse.

For many years the Dutch have been using artificial light to force their bulb crops. There have been a few reports in the Unted States about the possibilities of using lights for forcing bulbs, but the details of the procedure are not well known. The use of artificial light to force bulbs and azaleas is applicable for both large and small growers. The work to be reported here is preliminary and more work must be done on the quality of light used.

Tulips, hyacinths and daffodils can be forced under low intensity light because these plants are complete flowering units at the start of forcing. That is, when the bulb is removed from storage, all of the flower parts are completely developed and it has enough stored food and minerals to complete its growth. The leaves, therefore, do not have to produce all of the food that the plant uses, as is the case with most other florist crops.

These bulbs could be forced in complete darkness, but some light is required for the formation of chlorophyll. Light also helps to produce some carbohydrates for plant growth. Heat (60° to 70°F) is needed to break the dormancy and start the bulb growing and water stretches and fills out the cells which were formed during the storage period.

EXPERIMENTAL

Three chambers, six and one-half feet square and a 60°F constant temperature greenhouse were used as the growing areas. The temperatures in the chambers were maintained at about 60°F. In some of the late work, a room which was maintained at 70°F and a 70°F constant temperature greenhouse were used. Three light sources were used. These were incandescent, fluorescent and mercury vapor lamps. The wattage in each one of the compartments was approximately 400, which was equal to about 10-watts per square foot. The incandescent light chamber contained ten 40-watt bulbs, the fluorescent light chamber contained thirteen 30-watt tubes and the mercury light chamber contained one 400-watt bulb.

In a later trial in the 70°F temperature chamber the size of the incandescent bulbs was increased from 40 to 100 watts to give 25-watts per square foot instead of 10-watts per square foot.

The distance from the lights to the platform on which the flats and pots were placed was approximately three feet.

The duration of the light period was 16 hours per day and was controlled by a 24 hour time clock. The flats and pots were watered daily. The stems were cut when the flower first opened. The tulips were measured from the cut to the tops of the flower and the daffodils were measured to the bend in the neck of the flower.

The tulips and daffodils were supplied by a commercial grower and had already received the proper storage treatments. Each flat contained 25 to 35 bulbs.

RESULTS: DAFFODILS

The variety King Alfred was used. The flats were lifted and placed in the forcing chambers on January 4, 11, 30 and February 13, 1957. The data as recorded at the end of the experiment are Shown in Table 1.

TABLE 1. The average length, weight and time to flower King Alfred daffodils which were forced at 60°F under three light sources (incandescent, fluorescent and mercury) and in a greenhouse starting January 4, 11, 30 and February 13, 1957.

Starting Date and Treatment	Av. Length (Inches)	Av. Wgt. (Ounces)	Date of Flowering Period Start	End	No. days from start of forcing until final cut
January 4—					
Incandescent	17.3	1.14	1/25	2/5	32
Fluorescent	18.2	1.22	1/25	2/5	32
Mercury	17.7	1.19	1/27	2/9	36
Greenhouse	15.1	.91	1/26	2/9	36
January 11—					
Incandescent	17.4	1.20	1/30	2/11	31
Fluorescent	18.0	1.05	2/1	2/11	31
Mercury	17.6	1.17	2/3	2/16	36
Greenhouse	16.0	1.03	1/31	2/11	31
January 30—					
Incandescent	17.7	1.30	2/10	2/19	31
Fluorescent	18.4	1.30	2/10	2/19	20
Mercury	18.3	1.35	2/12	2/19	20
Greenhouse	16.0	1.02	2/11	2/19	20
February 13—					
Incandescent	16.5	1.13	2/24	3/3	18
Fluorescent	19.5	1.34	2/25	3/4	18
Mercury	19.5	1.25	2/27	3/4	19
Greenhouse	17.4	1.22	2/25	3/3	18

The date of the first cut was about the same for all treatments. The average length of the stem varied with

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each treatment and planting time, but generally the flowers were longer under the artificial light treatment The flower color in all treatments was good. The foliage color, however, did vary. The greenhouse and fluorescent treatments produced plants with foliage of about the same color, but the incandescent treatment produced plants with lighter foliage but were still of salable quality. The mercury light treatment produced plants with the lightest foliage. The strength of stems was good in all treatments with the exception of plants grown under mercury light which, in some cases, produced weak stemmed flowers.

TULIPS

Four varieties of tulips were used: Paul Richter, Red Pitt, William Pitt and Harvest Gold. The bulb size was 12 centimeters and up.

Bulbs of the variety Paul Richter were forced starting January 4 and 11. The results are shown in Table 2.

TABLE 2. The average length, weight and number of days to force Paul Richter tulips at 60°F under three light sources (incandescent, fluorescent and mercury) and a greenhouse, starting January 4 and 11, 1957.

Starting Date and Treatment	Av. Length (Inches)	Av. Wgt. (Ounces)	Date of Flowering Period Start	Date of Flowering Period End	No. days from start of forcing until final cut
January 4—					
Incandescent	14.9	.93	2/4	2/11	38
Fluorescent	14.2	.90	2/4	2/9	36
Mercury	15.2	1.03	2/9	2/16	43
Greenhouse	11.0	.73	2/6	2/10	37
January 11—					
Incandescent	16.7	.82	2/10	2/12	32
Fluorescent	15.1	.90	2/10	2/15	35
Mercury	16.8	.94	2/13	2/18	38
Greenhouse	12.7	.77	2/10	2/17	37

As can be seen from Table 2 the average stem length of the tulips forced under lights was three to four inches greater than those forced in the greenhouse. The tulips grown under artificial light, except for the plants grown in the mercury light treatment, flowered earlier than those grown in the greenhouse.

The variety Red Pitt was forced beginning on January 30 and February 13, 1957. The results are shown in Table 3.

The stem length of the tulips grown under the various light treatments was three to seven inches greater than the plants forced in the greenhouse. This variety forced quicker under the light treatments than in the greenhouse.

The variety William Pitt was forced, using the same treatments as used with the previous varieties, starting on February 27, 1957. The results are shown in Table 4.

The results again showed that plants of this variety also produced longer stems and flowered faster under artificial light than tulips forced in the greenhouse.

On April 2, 1957, two varieties, William Pitt and Harvest Gold, were divided into two groups. One group was placed under the the four treatments previously mentioned at 60°F. The second group was forced at a 70°F

TABLE 3. The average length, weight and number of days to force Red Pitt tulips at 60°F, under three light sources (incandescent, fluorescent, mercury) and a greenhouse, starting January 30 and February 13, 1957.

Starting Date and Treatment	Av. Length (Inches)	Av. Wgt. (Ounces)	Date of Flowering Period Start	Date of Flowering Period End	No. days from start of forcing until final cut
January 30—					
Incandescent	20.4	1.08	3/1	3/4	33
Fluorescent	18.2	.97	3/1	3/5	34
Mercury	20.5	1.15	3/3	3/7	36
Greenhouse	13.3	.73	3/1	3/14	43
February 13—					
Incandescent	21.8	1.08	3/11	3/15	30
Fluorescent	18.2	.93	3/14	3/15	30
Mercury	19.5	.93	3/15	3/19	34
Greenhouse	15.2	.80	3/15	3/21	36

TABLE 4. The average length, weight and number of days to force William Pitt tulips at 60°F under three light sources (incandescent, fluorescent and mercury) and a greenhouse, starting February 27, 1957.

Starting Date and Treatment	Av. Length (Inches)	Av. Wgt. (Ounces)	Date of Flowering Period Start	Date of Flowering Period End	No. days from start of forcing until final cut
February 27—					
Incandescent	23.3	1.22	3/22	3/26	27
Fluorescent	21.5	1.12	3/24	3/27	28
Mercury	23.3	1.26	3/26	3/29	30
Greenhouse	16.4	.83	3/25	4/1	32

constant temperature. In this group, the mercury light treatment was eliminated and an incandescent treatment of 25 watts per square foot was used. The results are shown in Table 5.

Generally, the stem length of the tulips grown at 70°F was a few inches shorter than the stem length of the plants grown at 60°F, but the forcing period was shortened by five to eight days. The increase in the intensity of light, resulting from an increase in wattage from 10 to 25 watts per square foot, of the incandescent treatment at 70°F did not effect the length of the forcing period. The increased intensity also had no effect on the color of the foliage. The tulips in the incandescent treatments produced foliage of a lighter green color than the other treatments, but the stems were saleable. Harvest Gold was used in this experiment because it normally shows symptoms of "topple". There was some "topple" in all of the treatments in the greenhouse and under artificial light.

HYACINTHS

Hyacinths were forced under the three light treatments (incandescent, fluorescent and mercury) and in a 60°F greenhouse starting January 22, 1957, Fig. 1 is a picture of the plants one month after the starting of forcing. It is seen that the light treatments produce a plant of good quality with longer stems in approximately the same time as plants forced in the greenhouse.

AZALEAS

The forcing of Azaleas may be considered similar

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TABLE 5. The average length, weight and number of days to force William Pitt and Harvest Gold tulips using two forcing temperatures (60° and 70°F) under three light sources (incandescent fluorescent and mercury) and greenhouse, started April 2, 1957.

Treatment	Av. Length (Inches)	Av. Wgt. (Ounces)	Date of Flowering Period Start	Date of Flowering Period End	No. days from start of forcing until final cut
WILLIAM PITT					
70° Forcing Temperature—					
Fluorescent	19.9	.95	4/14	. . .	12
Incandescent	21.1	1.14	4/14	. . .	12
(10-watts per square foot)					
Incandescent	21.8	1.13	4/14	. . .	12
(25-watts per square foot)					
Greenhouse	18.0	1.03	4/14	4/15	13
60° Forcing Temperature—					
Fluorescent	24.2	1.29	4/20	4/22	20
Incandescent	21.8	1.17	4/16	4/19	17
Mercury	23.3	1.31	4/20	. . .	18
Greenhouse	20.9	1.23	4/20	. . .	18
HARVEST GOLD					
70° Forcing Temperature—					
Fluorescent	22.7	1.10	4/14	. . .	12
Incandescent	21.9	1.08	4/14	. . .	12
(10-watt per square foot)					
Incandescent	20.7	1.12	4/14	. . .	12
(25-watts per square foot)					
Greenhouse	18.0	.91	4/14	4/15	13
60° Forcing Temperature—					
Incandescent	21.5	1.12	4/16	4/15	13
Fluorescent	23.2	1.16	4/19	4/20	18
Mercury	25.6	1.22	4/19	4/20	18
Greenhouse	18.9	.92	4/20	4/22	20

FIGURE 1. Hyacinths forced at 60° under three light sources (incandescent, fluorescent and mercury vapor) and a greenhouse starting January 22, 1957. The photograph was taken February 25, 1957.

to that of tulips, daffodils and hyacinths since the flower parts are all formed at the time the plants are removed from storage. The forcing period then is a time when the flower parts expand. The situation is not exactly similar, however, in that it is necessary for the leaves to produce all of the food supply during the forcing period.

The same light and temperature treatments as mentioned previously were used to force azaleas. The following varieties were used: Coral Bells, Salmon Bells, Pride of Detroit, Pink Giant, Salmon Queen and an Indica. The treatments were started on January 22, February 14, March 14 and April 13, 1957.

Since there was variation within each variety and only two plants were used per treatment at any one starting date, no numerical data were recorded. The results did not show any great differences between treatments. The time from the start of forcing until the plates were ready for sale was about the same in all treatments. The leaf color of plants forced under the light treatments was as good as the leaf color of plants forced in the greenhouse. The lasting quality of the plants in all treatments was the same. There was greater variation between plants of the same variety than there was between treatments. Generally, however, there was a difference in flower color. The flowers produced by plants under the light treatments were lighter than those forced in the greenhouse.

DISCUSSION:

Azaleas, hyacinths, tulips and daffodils can be forced under artificial light. The quality and the size of the plants forced under artificial light was equal to or better than similar material forced in the greenhouse. Generally, the time of forcing was less when the plants were forced under artificial light. This was especially noticed with the tulips during January and February. As the season progressed the plant material forced quicker in all treatments and the differences in forcing time were lessened.

This means that a greenhouse is not necessary to grow these crops. A wooden or cinder block structure would be much cheaper to build and heat than a greenhouse. Also, many growers already have bulb or azalea storage or other storage structures, which could be used for forcing.

One of the big advantages of using artificial light is that the plant material can be grown on shelves, that is, racks could be built and the same floor area could be used to grow two, three, or four times the amount of plant material as could otherwise be grown in a greenhouse of equal floor area.

Standard cool white fluorescent tubes produce the best type of light for the growth of these crops. For a permanent installation a fluorescent lighting system would be expensive, but the tube replacement, maintenance, etc. is low. The incandescent lighting system is the cheapest to install, but does have drawbacks. It was found that the foliage of both tulips and daffodils was lighter in color than the foliage produced under natural or fluorescent light. The incandescent light also produces more heat than the fluorescent and in some cases this could present a problem. The mercury vapor lamps were not satisfactory. This winter further work will be done on light combinations, (fluorescent and incandescent), to try to produce

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good foliage color with a cheaper installation.

The basic rule for setting up this lighting program is to space the lights evenly over the area and use 10-watts of light per square foot; i.e, one 40-watt bulb will light four square feet. The lights should be placed about three feet (for short plant material like hyacinths or azaleas two feet is sufficient) from the platform and operate for 16 hours per day. The temperatures required are the same as would be used in a greenhouse. As was shown in Table 5, the higher the temperature, the faster the bulbs will force and consequently, the shorter the stems.

Heat and ventilation should be provided. During the period when the lights are operating some method of ventilation is necessary to remove the heat produced by the light. When the lights are not operating heat is necessary to maintain a 60° or 70°F temperature.