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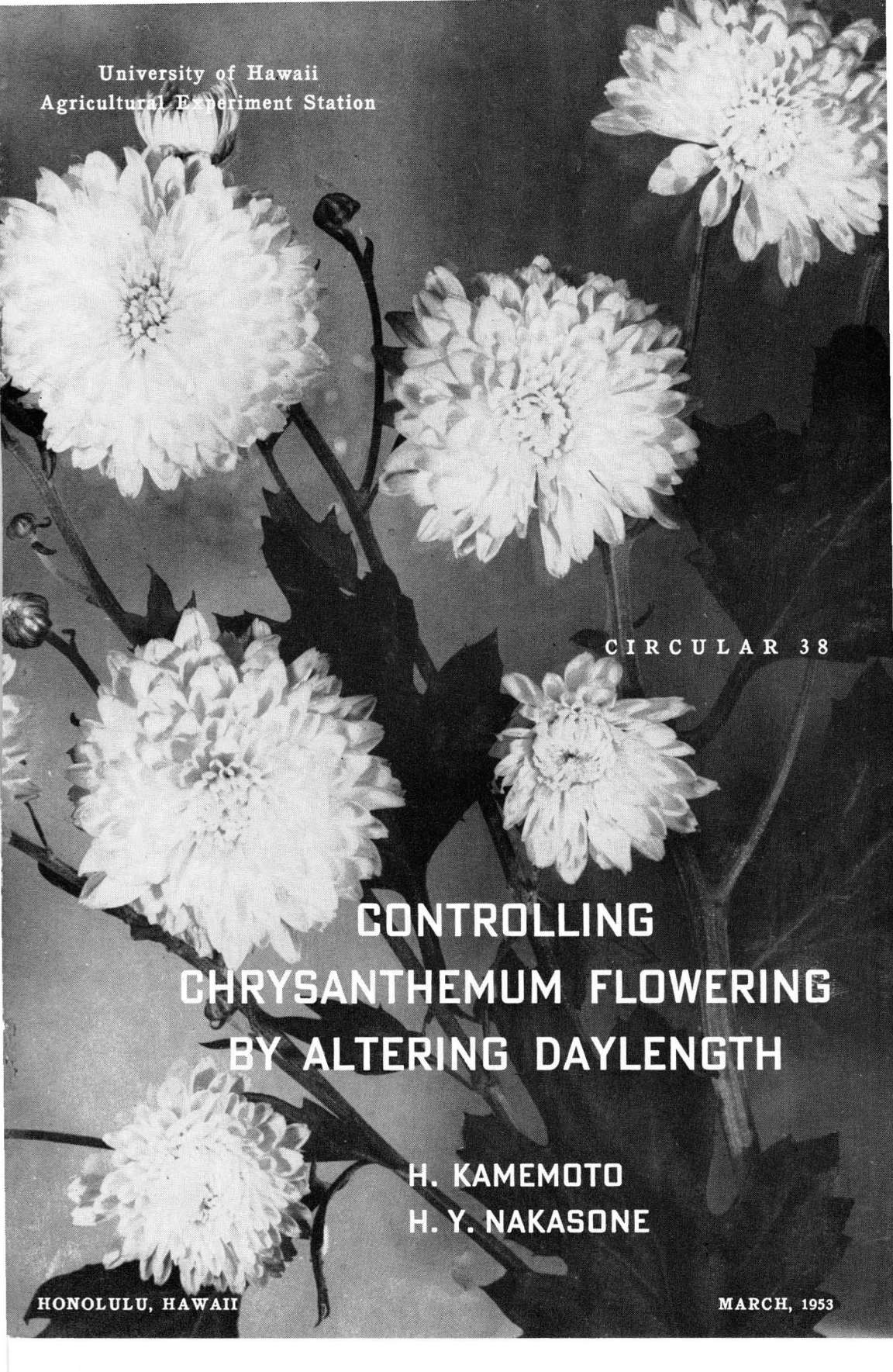
Agricultural Experiment Station



CIRCULAR 38

# CONTROLLING CHRYSANTHEMUM FLOWERING BY ALTERING DAYLENGTH

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Although chrysanthemums are popular in Hawaii, their production has never reached major proportions. This is primarily because daylength is an important factor affecting the growth and flowering of chrysanthemums. They are short-day plants and, consequently, start flowering in fall. Island growers have not attempted to extend or control the flowering period, but on the Mainland, a considerable amount of research on the response of chrysanthemums to daylength has led to year-round commercial production in some greenhouses.

These flowers need daylength of 14½ hours or less for flower buds to initiate, and 13½ hours or less for flower buds to develop (Post, 1947). With this basic information, it is not difficult to keep chrysanthemums in a completely vegetative condition by extending the daylength to 14½ hours or more or to make them flower by reducing the daylength to 13½ hours or less. Work at this Station has shown that the methods developed to control flowering in Mainland greenhouses can be adapted to the outdoor culture of chrysanthemums in Hawaii.

## NORMAL BEHAVIOR OF CHRYSANTHEMUMS IN HAWAII

The longest day, June 21, including civil twilight,[1] in Hawaii (Oahu) at 21 degrees N is 14 hours and 15 minutes, and the shortest day, December 21, is 11 hours and 19 minutes. The fluctuation in daylength between summer and winter is only 2 hours and 58 minutes. As one goes farther north, this difference becomes greater. The longest day in Hawaii is shorter than the critical daylength for flower bud initiation; consequently, budding occurs throughout the summer months. These initiated buds, however, do not develop until a shorter daylength is reached. Frequently the arrested bud development is followed by vegetative growths and their subsequent budding. The alternating budding and vegetative growth during summer ultimately result in a profusion of flowers on highly branched flower stems (fig. 1).

[1] The intervals of time between sunrise or sunset and the instants when the center of the sun is 6 degrees below the horizon.

The normal flowering dates for most chrysanthemum varieties in Hawaii coincide with those for the same varieties grown at Barberton, Ohio (latitude 41 degrees N), in spite of the differences in daylength. Although buds are initiated earlier in Hawaii, the development of these buds is arrested or retarded to a degree that permits flowers to appear about the same time as in Ohio.

After the fall crop is harvested, the practice in Hawaii is to cut the stems back near the base to produce new growths. Frequently the new shoots grow only a few inches, then bud and flower around January and February. These flower stems are too short for most commercial purposes. The short daylengths during the winter months are responsible for this behavior.

## SHADING FOR SUMMER FLOWERING NOT PRACTICAL

To produce flowers during the summer, the days need to be shortened to less than 13½ hours daylength. On the Mainland, black sateen cloth with a minimum thread count of 68 x 104 to an inch is used to cover the plants. The cloth is usually put on in the evening and taken off during the morning. To be effective, the treatment must not admit more than 2 foot candles of light.

With the prevailing price of chrysanthemums here, it is impractical to shade chrysanthemums for summer flowers. The relatively high cost of the cloth and the labor involved in putting on and taking off the cloth each day make this practice prohibitive in Hawaii.

## LIGHTING TO CONTROL FLOWERING

From the normal date of flowering in the fall, through May, many varieties can be timed precisely, easily, and economically. During this period, the days are short enough to effect budding and flowering. To keep the plants in a vegetative condition, it is necessary to lengthen the day by means of artificial light. Mazda lamps with suitable reflectors will serve the purpose. The mounting height and the spacing of the lights will depend on the size of the bulb used. Seventy-five-watt bulbs can be mounted 4 feet above the ground and spaced 6 feet apart (fig. 2). The best period to illuminate the plants is during the middle

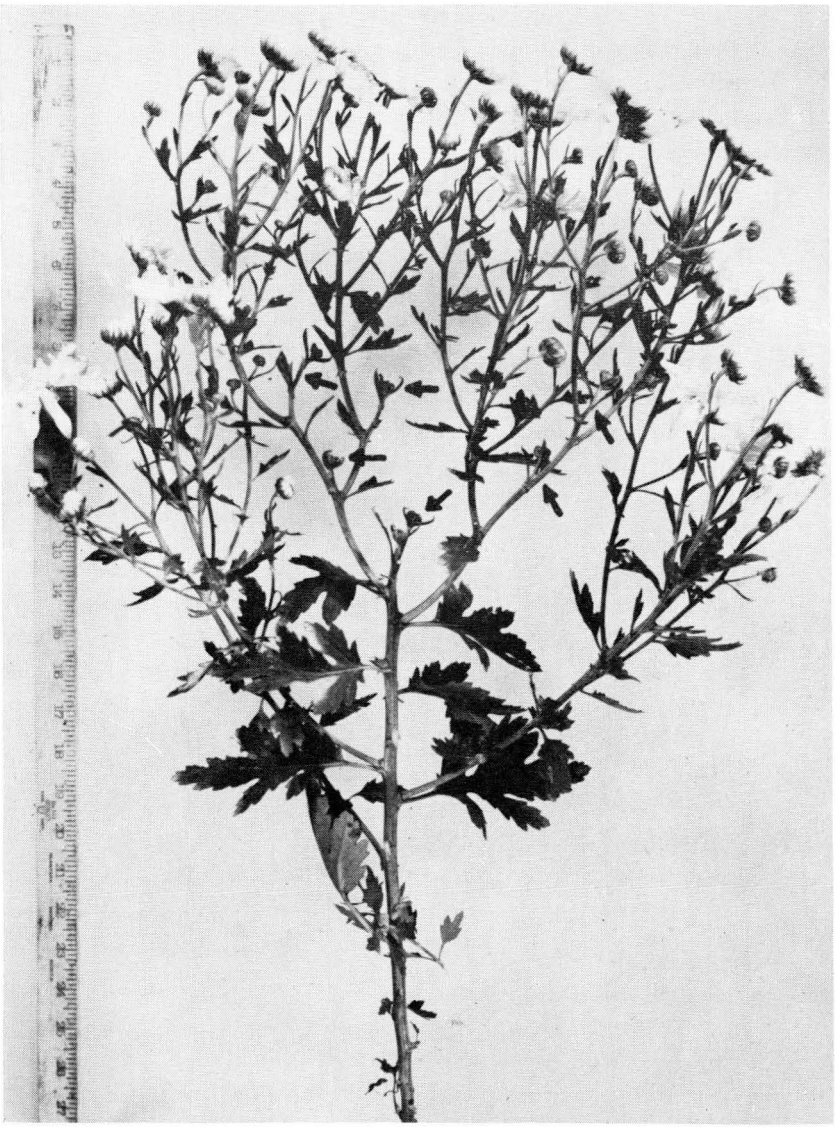

Figure 1. Normal flowering behavior in Hawaii. Note the successive budding and vegetative growth which resulted in an undesirably branched flower stem. The arrows indicate the arrested buds. This variety, Detroit News, flowers around November 5 in Hawaii.

of the night. A time clock can be equipped to turn the lights on around 11 P.M. and off around 2 A.M. each night.

To control flowering, the plants must be exposed to long day conditions until the time bud initiation is desired. Then, from the period of bud initiation to flowering, short days are necessary. Since the days are short enough from September through May, shading is not necessary during this period.

Chrysanthemum varieties can be classified according to the number of days from period of bud initiation to flowering required by the plants.[1]

Figure 2. Controlled flowers. This ratoon crop was timed for Easter through the use of artificial lights.

Gold Coast, a yellow pompon, is a 9-week variety; Indianapolis White, a white standard, is a 10-week variety. The variety Gold Coast normally flowers around November 1. If flowers are desired for Christmas, December 25, instead of November 1, bud initiation should be delayed till October 23. The plants must be exposed to supplementary lights prior to October 23 to keep them from budding. The number of days

[1] Classified lists of varieties appear in catalogs put out by Yoder Brothers, Inc., Barberton, Ohio.

the plants are to be exposed to long days is dependent on the length of stems required. The longer this period, the greater the ultimate length of stem. A month of vegetative growth usually suffices to give 30-inch stems, which are long enough for most purposes. Thus, the terminal portion of the stems are removed 1 month prior to the desired date of bud initiation. This practice is called pinching and is done to obtain three to four stems per plant. This pinching date is September 23. Two weeks ahead of the pinching date, the rooted cuttings are planted. It takes around 3 to 4 weeks for the cuttings to root.

The schedule for flowering the Gold Coast variety for December 25 is repeated below:

| | |
|---|---|
| Before August 11 | Light stock plants |
| August 11 | Root cuttings |
| September 9 | Plant in field. Light until October 23 |
| September 23 | Pinch |
| October 23 | Buds should initiate. Remove supplementary lights |
| December 25 | Flower |

The quality of flowers obtained by controlled daylength is superior to those obtained under normal daylength conditions (fig. 3).

## TIMING THE RATOON CROP FOR EASTER

The ratoon crop to follow the Christmas crop can be timed conveniently for Easter. The stems are cut back to permit a new flush of growth. Daylength treatments should begin immediately after cutting to encourage vegetative growth. If light treatment is not given, buds will form after a very short period of vegetative growth and very short flowering stems will result. Pinching is not necessary with the ratoon, for many shoots will develop from a single plant.

A schedule like that for the Christmas flowers can be set up for Easter flowers. If Easter falls on April 5, the buds of the variety Gold Coast must be initiated on February 2. Lights are supplied from the

Figure 3. Comparison of flowers of the variety Gold Coast obtained under normal and controlled daylengths. Left: normal daylength. Note the branching stem with many flowers. Right: controlled daylength. Note the single long stem with a well-formed head of flowers.

day the plants are cut back until February 2. The two schedules can be combined as follows:

| | |
|---|---|
| Before August 11 | Light stock plants |
| August 11 | Root cuttings |
| September 9 | Plant in field. Light till October 23 |
| September 23 | Pinch |
| October 23 | Remove supplementary lights. Buds should initiate |
| December 25 (Christmas) | Flower |
| January 2 | Cut stems back near base. Supply lights |
| February 2 | Remove supplementary lights. Buds should initiate |
| April 5 (Easter) | Flower |

## THREE CROPS A YEAR FROM A SINGLE PLANTING

Three crops a year from a single planting in early summer can be obtained from earlier varieties without resorting to shading. Bright Forecast, a yellow pompon, can be classed as a 8-week variety. It normally flowers around October 18. If lights are supplied immediately after cutting the fall crop back, the first ratoon can be produced as early as February. After the second crop is cut back, lights can be supplied once again and the second ratoon can be produced in May. The following schedule is set up to obtain three crops of this variety.

| | |
|---|---|
| October 12-18 | Flower |
| October 25 | Cut remaining stems back and supply lights |
| November 25 | Remove supplementary lights. Buds should initiate |
| January 20 | Flower (first ratoon) |
| February 1 | Cut remaining stems back. Supply lights |
| March 1 | Remove supplementary lights. Buds should initiate |
| April 26 | Flower (second ratoon) |

The second ratoon can be timed for Mother's Day (second Sunday in May) or Memorial Day (May 30), if desired. The important consideration is the removal of lights 8 weeks prior to the date flowers are expected.

## DIFFERENCES DUE TO VARIETIES

Considerable differences in response to daylength are found among the various varieties. As mentioned earlier, they differ in the normal date of flowering, some being early, others medium or late. Also, some varieties respond well to supplementary light treatments, while others do not. It is necessary, therefore, to test the different varieties and select those that are suitable. Among the varieties investigated at this Station, Bright Forecast, Gold Coast, Little America, and Masterpiece are promising for outdoor production under daylength control.

A few varieties flower throughout the long days of summer in Hawaii. Some of these are Honeycomb, Bright Forecast, and White Wonder. The planting date must be early, sometime during March or April, to flower these during summer.

## CHRYSANTHEMUMS EVERY DAY OF THE YEAR IN HAWAII

It is possible to flower chrysanthemums the year round in Hawaii through controlled daylength. However, shading during the summer is unprofitable. Fortunately, some varieties will flower during the long days of summer. From October through May, chrysanthemums can be produced economically through the use of supplementary lights. Furthermore, they can be timed precisely for any particular date during this period.

On the slopes of Haleakala, in the Kula section on the island of Maui, varieties that normally flower during the fall in Honolulu have been demonstrated to flower throughout the summer without any artificial alteration of daylength. The quality of flowers obtained was excellent. The reason for this behavior has not been established. Possibly the slight reduction in daylength due to the mountain and the usual overcast toward evening or the prevailing low night temperatures, or both, are effecting this early flowering. The high-quality chrysanthemums obtainable in Kula during the summer without resorting to the expensive practice of shading,

the use of some varieties that flower in summer at low elevations, and the practicability of timing the crop for any day from early October to late May through the use of artificial lights will make it feasible to produce chrysanthemums every day of the year in Hawaii.

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