COLORADO FLOWER GROWERS ASSOCIATION

Bulletin 315 Edited by David E. Hartley 1976

YIELD PREDICTION STUDIES ON CARNATIONS

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Successful prediction of carnation flower yield and timing is a major factor in determining profitability. Most growers combine experience and past records to plan peak production periods, and to estimate how many flowers will be produced in a given time. Growth rate, however, is influenced by light and temperature which may vary unpredictably from week-to-week. Yield estimations always have had an element of uncertainty.

Our objective was to see if the time for flowering could be made more accurate by measuring such factors as light and temperature, and relating them to the number of weeks required to produce a carnation cut-flower. The study was limited by the considerable data and plant measurements required. We did find, as expected, that effects of solar radiation and temperature were significant and interdependent. That is, either temperature or radiation measurements alone could be related to time-to-flower. However, there was a large variability which could not be accounted for by manipulation of the factors measured; such as temperature, light, CO_2 concentration and break length. There did appear to be an "upper limit", or maximum number of weeks required for a break to flower at any given average weekly temperature or solar radiation. Flowering did occur sooner, but seldom took longer than a fairly well-defined limit. These results were encouraging, and may provide a basis for further work.

Methods

Rooted cuttings of 'White Pikes Peak' were planted in two 35″ × 35-foot benches, 3 plants per sq.ft., on September 28, 1973, and single pinched on October 23. Bench I, gravel, was in a glass-covered house oriented east-west, and watered 2 to 5 times daily, depending upon the season, with Chapin, double-wall tubes. Bench II, soil, was in a fiberglass-covered house, and watered as required with a similar system. Fertilizer was injected at each irrigation. The glass house (House 1) was controlled at a night temperature of 52°F, heated to 62°F during the day, with ventilation beginning at 67°F. House 2 (fiberglass-soil) was heated to 55°F at night, with the same day temperature settings. Carbon dioxide was injected into each house.

Solar radiation was measured in each house with a silicon cell. The area under the recorded curve was measured, and accumulated to provide a weekly average solar radiation intensity in g-calories per square centimeter. Temperature was continuously recorded at centrally located, aspirated shelters. The areas under these curves were measured and converted to average weekly temperature. CO_2 concentrations were determined twice daily and averaged to provide a weekly CO_2 level for each house.

The first flower was cut from Bench I (glass-house) on January 16, 1974, and from Bench II (fiberglass) on February 25, 1974. From April 15 through May 29, every plant that had a flower cut from it was tagged at the point where the flower was cut. If the top node had a break, it was measured.

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From May 29 through November 25, every other cut flower was tagged. When the tagged cut eventually flowered, the time from cut-to-cut was determined. This was correlated with CO_2 concentration, temperature, light intensity and break length.

Each bench was divided into 10 plots, 5 on the north side and 5 on the south side. Every two weeks, starting April 2 and continuing to August 6, 1974, a 4 cm break from each plot was chosen randomly and tagged. On those selected, the break length was measured weekly until the buds were ½-inch in diameter. The last recorded information was the date the flower was cut.

Results

The weekly production for each house is shown in Figure 1. The first week of the year was week Number 1, with data taken between April 9 (week 15) and November 25, 1974 (week 46), as indicated by the vertical arrows. Several types of correlations were attempted between weeks-to-flower as the dependent variable, average weekly radiation, average weekly temperature, average weekly CO_2 concentration and break length. None of these separately, and in various combinations, reduced the variability that existed sufficiently for good correlations. As would be expected, there was a definite relationship between weeks-to-flower and break length (Figure 2). Figure 2 shows the marked variability — each cross indicating one or more cut flowers. For example, the time for flowering for a break 15 cm (6 in.) in length varied as much as three months. Note, however, that there appeared to be a "lower limit" (line b). That is, a 15 cm break required at least 12 weeks to flower, and as many as 26 weeks, depending upon conditions other than size.

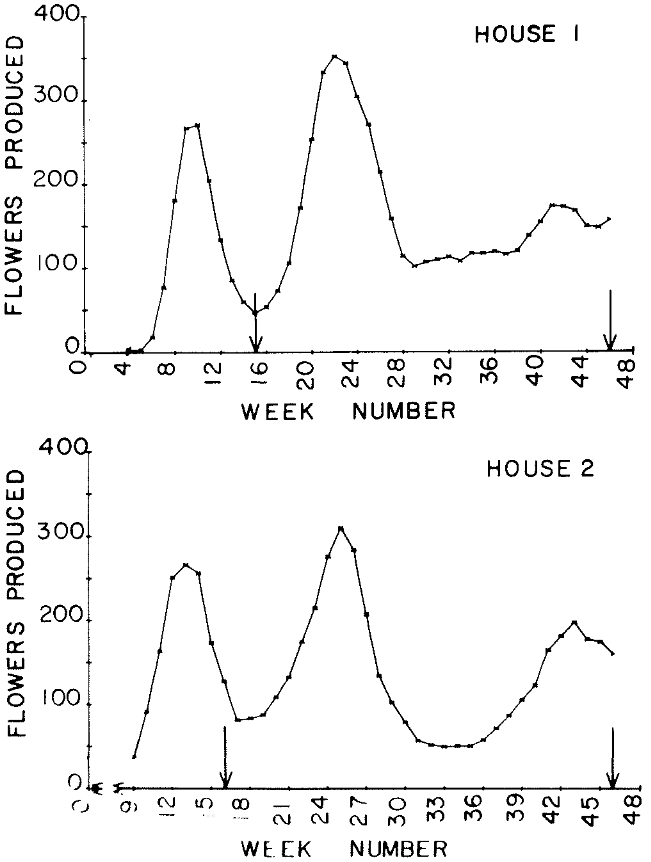

Fig. 1: Three week moving mean of flower production in glass house 1 and fiberglass house 2, both planted on September 28, 1973, and given a single pinch October 23, 1973. The first week of the year was week Number 1. The vertical arrows show when data were collected.

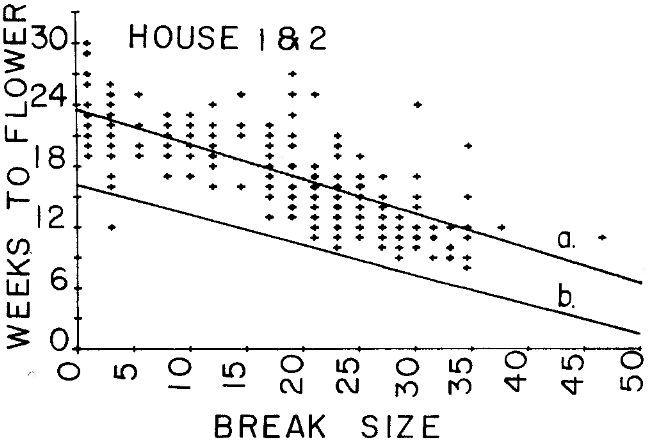

Fig. 2: Scattergram showing the number of weeks required for a break to flower as a function of break size (cm) when tagged. Line "a" was calculated mathematically, line "b" drawn by inspection to demonstrate minimum flowering time according to break size. Each cross represents one or more cut flowers.

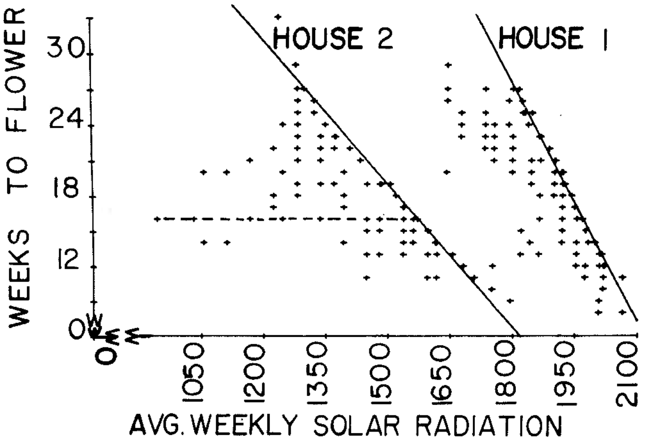

Fig. 3: Scattergram of the number of weeks required to flower as a function of average weekly solar radiation. The graph includes only those flowers which had a break visible when initially tagged. The lines were drawn by inspection to show that although the response to radiation was different for each house, the cut-off point for maximum time for flowering could be easily determined. Solar radiation is g-cal cm². The horizontal, dashed line to the left of the curve for House 2 represents data selected and tested mathematically for randomness. Each cross is one or more cut flowers.

Figure 3 is another scattergram showing the results when plotted as a function of solar radiation in the two houses. Again, no reasonable correlation could be obtained due to variability of the data. There was an obvious relationship, which, interestingly, was different for each house. The lines show the rather sharp "upper limit" found for each house. The curves show the maximum time required for a break to flower. Note, however, the spread of points for the horizontal dashed line at 15 weeks for House 2. The data representing these points were subjected to statistical analysis and found random. There was some factor — perhaps position in the bench — for which we had no measurement, which caused the variation.

Unlike average solar radiation, data from both houses could be combined when weeks-to-flower were plotted as a function of average weekly temperature (Figure 4). Referring to Figure 4, one might state that the flowering time would not be more than a maximum number of weeks for a given average temperature. That is, for example, if a crop were desired in 18 weeks or less (line b), the average temperature should be 64°F or higher (line c). The first flower may be harvested earlier, but the last should be cut within 18 weeks. Note that "average temperature" included both day and night records.

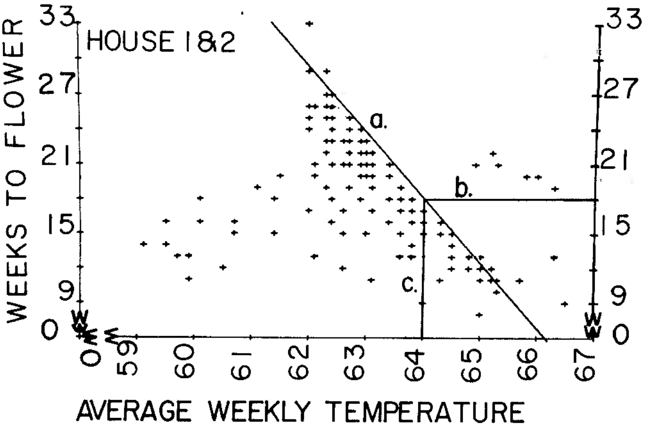

Fig. 4: Scattergram of the number of weeks required to flower as a function of average weekly temperature. The graph includes only those flowers that had a break visible when initially tagged. Line "a" was drawn by inspection. As an example, lines "b" and "c" were drawn to illustrate that nearly all breaks had flowered in 18 weeks when grown at an average weekly temperature of 64°F. Note that "average temperature" includes night and day values. Each cross represents one or more tagged cut flowers.

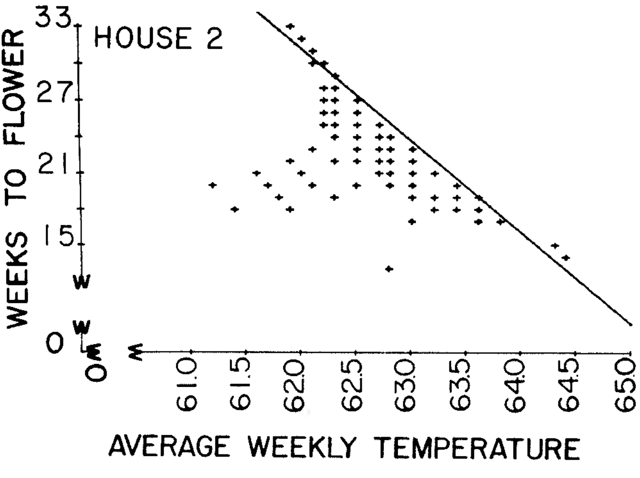

Fig. 5: Time required for carnations to flower as a function of average weekly temperature (°F) when there were no visible breaks when tagged (previous flower cut). Each cross represents one or more cut flowers. Note that average weekly temperature includes both night and day values.

Flowers tagged having no breaks at the time of tagging showed similar results. The data for "0" breaks were statistically different from plants having a visible break at the time of tagging. Figures 2 through 4 deal only with those plants having visible breaks. Figure 5 shows a sample from House 2 for weeks-to-flower as a function of average temperature for carnations having no breaks visible at the time they were tagged. There appeared to be definite patterns when time-to-flower was based upon CO_2 concentration. However, the patterns were difficult to explain and subject to various interpretations. In the elongation study, where one plant with a 4 cm break was selected from each of ten plots in a bench every two weeks; there was no statistically significant difference due to position in the bench. This was probably due to the fact that each plot included an outside row as well as two inside rows. The variability due to both outside and inside rows was apparently so great as to preclude any reliable test for significance. Future tests of this kind should separate outside rows, and this may account for much of the difficulty encountered in this study.

Discussion

The idea behind this research was to test if a "normal" yield curve could be derived for carnations. Then, if suitable measurements are carried out during the current year, adjustments could be made to the "normal" curve in order to allow for current differences in light and temperature on time-to-flower. This was an attempt to build upon the work reported in earlier bulletins, particularly Koon's information in 1958 (CFGA Bulletin 108) and Holley's publication on crop forecasting in 1963 (CFGA Bulletin 160). These, and other articles (Bul. 110, 181, etc.) have pointed out the importance of light received and break length. The fact that we could use temperature to show the general effect on time-to-flower might have been due to the time of year when this study was carried out (late winter and summer).

Not all the data obtained in this study has been reported. In particular, it appears, that for a reliable prediction curve to be generated, we must account for break location in the bench (row and height on plant). We have in mind the possibility of standardized sampling procedures of selected bench areas. Unfortunately, the requirements for data collection exceed present resources in equipment and labor. The idea, however, is technologically feasible, and probably easier to apply to single cropping systems.