Responses of Carnation to Temperature II

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A. M. Abou Dahab (1967) prepared an exhaustive thesis on the effects of light and temperature on the growth and flowering of carnation. For the first time elaborate lighting and temperature experiments were reported on this plant. Many of his results confirmed early work that was done less systematically. In some of his experiments he was able to separate the effects of photoperiod, light intensity, and temperature. Abou Dahab's best experiments were completed in the growth chambers at the Laboratory of Horticulture, Wageningen, Holland. Since this paper deals with temperature responses, the light and photoperiod factors will be mentioned only when they interacted with temperature.

In the growth chambers under artificial light, internode length was greatest at 48 F and least at 59 to 64 F. Internodes were somewhat longer at 70 F. Stem length, which includes number of internodes as well as internode length, was greatest (78 cm.) at 48 F but tended to be just about as long at 70 and 75 F. The shortest stems (around 10 cm. shorter) were grown at 59 F. The thinnest stems were produced in warmer temperatures. The largest and heaviest flowers were produced at 59 F while the lightest were those grown at 75 F.

Abou Dahab studied the effects of 25 combinations of night and day temperature on carnation in another experiment. Although his temperatures were discontinued after 4 1/2 months due to mechanical difficulties, he placed all plants in a common temperature during the last 6 weeks and was able to take extensive data, especially on time of flower bud initiation and number of leaf pairs produced below the flower. He showed good evidence that these responses to temperature are regulated by a daily "heat sum." By multiplying the time under day temperature (8 hrs.) and the time under night temperature (16 hrs.) by the respective temperatures, and calculating the sum of these two products he was able to show that differences in time of bud initiation between plants grown with the same heat sum are negligible. Abou Dahab's conclusions in this experiment were that flower bud initiation in carnation depends upon the average daily temperature, and that night and day temperatures have no specific effect. He found that the lowest average temperature he used (52 F) was the most promotive.

Distinct day and night temperature effects were found on bud growth from initiation to flowering. 1) When day temperatures and night temperatures were the same, bud growth was fastest at higher temperatures. 2) At a specific day temperature, bud growth was favored by lower night temperatures. 3) With a specific night temperature, higher day temperatures promoted bud growth. His conclusion was that bud growth is affected in a specific and differential way by day and night temperature.

From this experiment Abou Dahab found that internode length is affected by night temperature with the longest internodes being produced at the coolest temperature — in this case 52 F. Stem length is somewhat more complicated since it is the product of length of internode and number of internodes. In spite of this the longest stems were produced at the higher day temperatures (70-75 F) and low night temperatures (52-64 F). The shortest stems occurred at low day temperatures (52-64 F) and higher night temperatures (64-75 F). Night temperature did not affect leaf length, but high day temperatures tended to decrease leaf length, especially if combined with low night temperatures. Leaf width showed an opposite effect. There was little response to day temperature. The broadest leaves were produced in lower night temperatures regardless of the day temperature. Higher night temperatures produced narrow leaves. Total dry weight (and probably fresh weight) was highest per stem and flower at night temperatures of 64 and 75 F. Day temperature did not have a significant effect on total dry weight. This last finding is entirely unexpected and needs confirmation under greenhouse conditions.

In his final set of experiments on temperature response, Abou Dahab investigated the use of a vernalization temperature of 40 F on subsequent growth of carnation. Many plants respond favorably to exposure to cold temperature during the early part of their cycle. This effect has often been claimed for carnation.

While a series of complex experiments were completed, a brief summary of his findings should outline the response of carnation to short periods of chilling. Flower bud initiation was promoted in shoots with seven expanded leaf-pairs exposed to 40 F for 18 to 24 days in fluorescent light. Shoots with six leaf-pairs showed some response while shoots with three or five leaf-pairs, expanded at the beginning of exposure, did not respond.

Plants (single shoots) were exposed to 40 F under fluorescent light for 0, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, or 36 days and then moved to a greenhouse for flowering. Eighteen to 24 days' exposure promoted flower bud initiation while shorter periods of exposure were not effective; longer periods were no more effective than 24 days, and even delayed flowering because of the additional days of exposure.

Photoperiod after exposure	Duration of 40 F						
	3 weeks SD	3 weeks LD	4 weeks SD	4 weeks LD	5 weeks SD	5 weeks LD	Control
Long day (16 hours)	80	81	85	86	89	88	100 = 194 days
Short day (8 hours)	70	67	74	70	72	71	100 = 249 days

Table 1. Relative time from planting of rooted cuttings to flowering for carnations exposed to 40 F for three periods, and interactions with photoperiod during and after treatment. Averages of eight plants.

Exposure to 40 F for 18-24 days at the stage of shoot development favorable for bud initiation reduced the total time to flowering. The effect depended to some extent on the photoperiod during exposure and to an even greater extent on the photoperiod following exposure (Table 1).

Other effects of vernalization were measured. Low temperature exposure increased the petal number slightly and caused a distinct increase in internode length. Affected shoots had from four to nine fewer internodes with the greatest difference on shoots grown under short days following exposure. Stem length was increased if shoots were subsequently grown under long days and decreased if grown after exposure under short days.

Whether we will be using this information in future production is not clear at this time. If single crops become popular, entire sections may be vernalized to gain longer stems and fuller flowers, or simply to save heat in January. It would be interesting to be able to measure the chilling effect on rooted cuttings that are held in cold storage, for surely there is an effect.

Currently, one of our major projects at Colorado State University is being done by Felix Muñoz. He is growing Pink Sim at all combinations of high and low night and day temperatures, the objective being to find out if low night temperature can be offset by slightly warmer day temperature. Felix is from the Universidad Agraria in Lima, Perú. His work here is made possible by his university and a grant from AID.

Literature cited

Abou Dahab, A. M. 1967. Effects of light and temperature on growth and flowering of carnation (*Dianthus caryophyllus L.*). Publication 298, Laboratory of Horticulture, Agricultural Univ., Wageningen, The Netherlands.