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Method of Forcing Carnations to Bloom to Meet Special Market Demand

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Abstract

A technique of forcing bloom of carnation for special market demand was developed. It enables ornamental growers to produce a large amount of cut carnation flowers during the intended period at a low cost. The outline of the technique is as follows. 1) Pinching shoots at the higher node and level them. By this treatment, many axillary buds start to grow simultaneously. 2) Carrying out shoot thinning and temperature control based on the degree of shoot growth. The date of budding, the bud size and the distance from the top of the pre-budding stem to the tip of the leaves can be used as indices for the estimation of growth and for the prediction of the flowering time. During the intended period of 12 days, the cut flower yield by this technique was as high as 20 stems per stock and 134 stems in each 1 m^2 bed area using standard type carnation cv. 'Francesco'. The appropriate time of the last pinching extended from the end of October to the middle of November in the warmer regions of Japan. In addition to the advantage of cost reduction by decreasing the number of carnation seedlings and fuel expenditure, this technique is suitable for continuous culture for 3 years.

Discipline: Horticulture
Additional key words: flower production, cut flower, training method

Introduction

In the warmer regions of Japan, the conventional method of cultivation of carnations is to plant them during June, and harvest them continuously from fall to the end of May. This cropping type has resulted in a leveling of the working hours and contributed to year-round employment and scale expansion. During the course of a year, the supply and demand for cut carnations are almost balanced. However, the demand increases sharply just before Mother's Day, and markedly decreases thereafter. Presently, no low cost production technique can meet these rapid changes in demand. In Japan, it is common for the wholesale price of carnations to fluctuate more than 10 times before and after Mother's Day. Under these circumstances, it is essential to develop a new technique.

Carnations have buds in each node and some of them grow slowly under ordinary conditions. On such occasions when the terminal bud changes to flower or is pinched, axillary buds begin to elongate immediately. At this time, all the axillary buds do not extend similarly, but only the upper 2 or 3 extend significantly. Furthermore, the flowering time varies among the buds. Based on these characteristics of growth of carnation, flowering periods are dispersed and the leveling of working hours is achieved under the present conventional cropping type.

We have selected an opposite approach from the conventional cultivation method to achieve intensive blooming in order to minimize the differences in growth among node positions, and to grow similarly as many axillary buds as possible. The technique must satisfy the following requirements: 1) The harvest period should coincide with the annually fluctuating date of Mother's Day. 2) The cost of nursery plants under the current method of cultivation should be reduced. 3) It should not be necessary to use a greenhouse with a high level of technology that leads to high depreciation costs. 4) To minimize the effect on the environment, fuel consumption should be reduced by low temperature cultivation, and the amount of applied fertilizer should decrease.

We developed a method which satisfies these requirements and can be applied for practical use[2,3]. It was referred to as the "Down And Up" cultivation technique (DAU technique). The outline of the method is presented schematically in Fig. 1.

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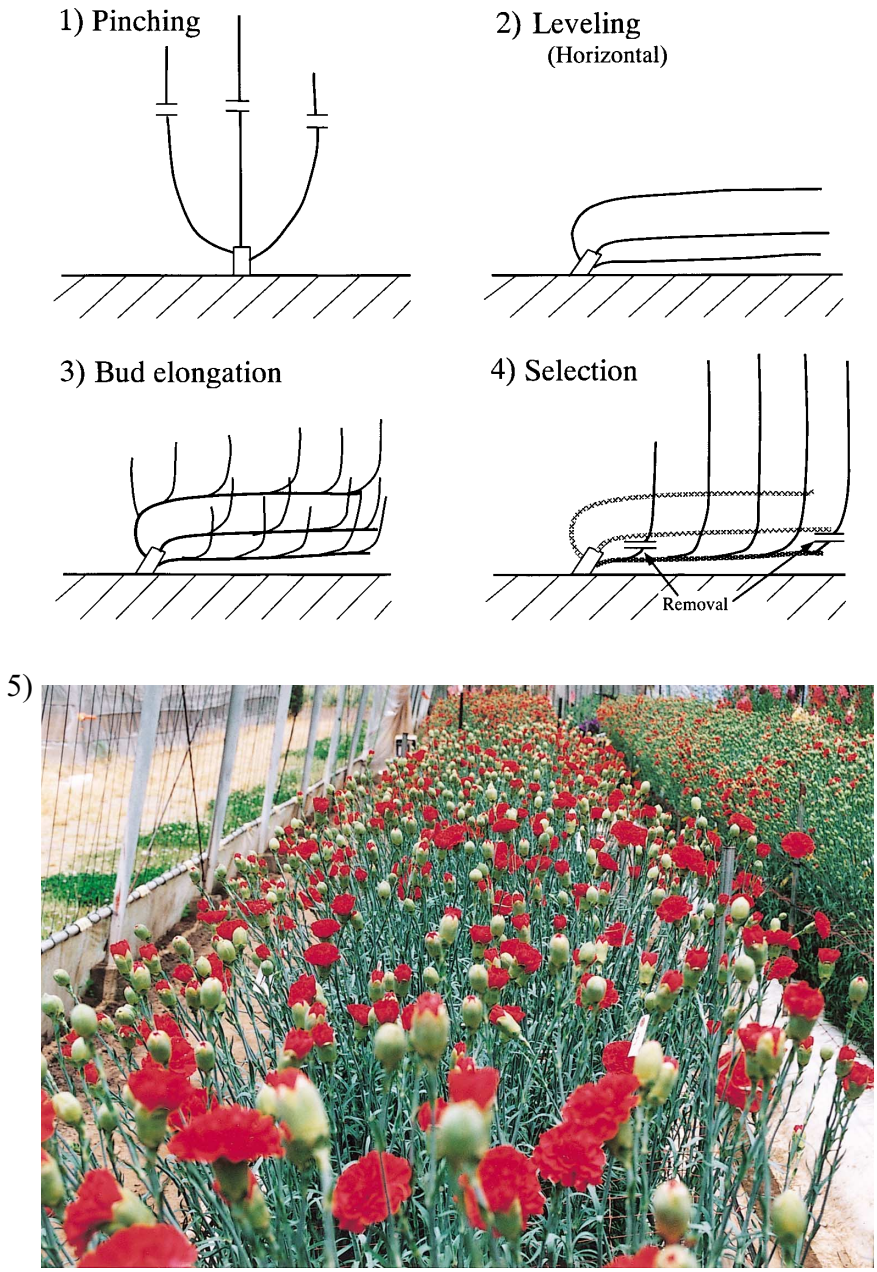


Fig. 1. Principle of "Down And Up" cultivation technique (DAU technique)

1) Pinching of shoot, to remove apical dominance. The pinching must be conducted at the higher node of the shoot (ca. 20 cm above the branching point), to obtain a large leaf area and many axillary buds.
2) Leveling of the pinched shoots. A net should be used to fasten them.
3) Many axillary and basal buds start to elongate simultaneously. The minimum temperature of the greenhouse should be slightly higher than the threshold of chilling injury. Low temperatures lead to uniform growth and exert a forcing effect on blooming during the warm conditions afterwards in the spring.
4) Based on growth indices, the shoots which are expected to flower during the intended period should be selected and others should be removed. The temperature should be controlled according to the growth status of representative shoots to minimize the effect of yearly changes in weather. To sum up, the DAU technique consists of 2 elements: Simultaneous elongation of axillary buds by pinching and leveling of stems, and selection of shoots which are allowed to grow to flower based on the prediction of the flowering time.
5) Forcing bloom in the greenhouse.

Materials and methods

1) Experiment 1: Growth indices for predicting the flowering time

Carnation cultivar 'Francesco' was used. It is the variety most generally grown among the standard red types in Japan. Cuttings which were inserted in a propagation bed on April 30, 1996, after potting, were pinched. Young plants were planted in 2 rows in a soil bed on October 7, 1996 in a greenhouse without heating. The bed, with an upper width of 75 cm, was mulched with a reflective film, which exerts a beneficial effect on carnation growth[6]. Distances between plants and rows were 30 and 40 cm, respectively (6.5 plants/m^2 bed area). On November 7, 1996, the shoots were pinched at the node between 20 to 30 cm above the branching point, and they were leveled to a horizontal position. For forcing bloom at the beginning of May 1997, the shoots were thinned. The day of budding (the day when the lower bract appeared) was investigated in relation to the flowering date. The temperature of the greenhouse was kept as high as possible, not exceeding 30ºC in the day time during the blooming period.

Preliminary cultivation for 2 years had been examined in a similar way, and it was confirmed that the following characteristics were useful as developmental indices: for buds, the length from the tip of the upper bract to the apex of the calyx; and for shoots before budding, the distance from the apex of the stem to the tip of the leaves.

2) Experiment 2: Appropriate time of the last pinching

Francesco carnations were propagated by cuttings on March 26, 1997. Pinched young plants were planted in 2 lines on a soil bed (6.7 plants/m^2 bed area) 100 cm wide on August 22, in a greenhouse covered with a plastic film. Other cultivation methods were similar to those described in Experiment 1. In summer and fall, shoots with bud appearance, were pinched occasionally. The stems were allowed to fall naturally. Three treatment plots were arranged according to the time of the last pinching: 1) 24 October 1997, 2) 3 November, 3) 12 November. The greenhouse was heated to maintain a minimum temperature of 5ºC. The number and quality of the cut flowers were recorded.

3) Experiment 3: Suitability for long-term culture with continuously cultivated stocks

Francesco, which bloomed around the beginning of May in 1997 in Experiment 1, was cultivated continuously in the unheated greenhouse. Until the middle of October, the shoots were pinched repeatedly to prevent the setting of flowers. In the second year of production, the last pinching was carried out on November 7, 1997, and the plants bloomed in the spring of 1998. In the third year, cultivation was continued in the same way as in the previous year, and the last pinching was performed on November 7, 1998. Daily yield and quality in the second and the third years were surveyed in the spring of 1998 and 1999. Excessive shoots were thinned in accordance to the formula of flowering prediction. Based on the electric conductivity of the soil solution, nutrients were controlled by giving only water or a nutrient solution containing 100 mg N /L for hydroponics.

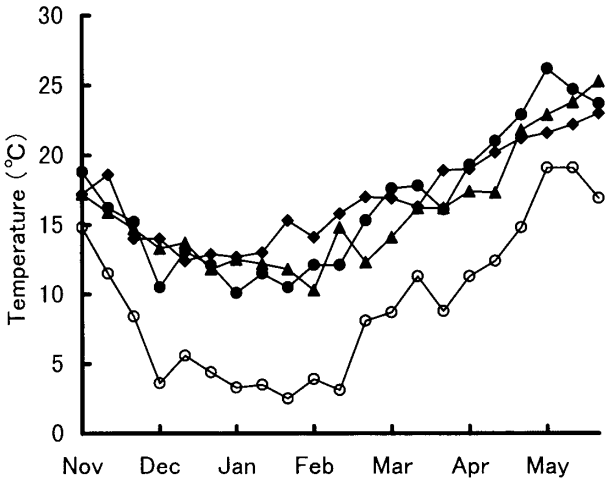
Fig. 2. Average and minimum te
average, 1997.
average, 1995.

Results and discussion

1) Experiment 1: Growth indices for predicting the flowering time

Changes in the average and minimum air temperatures in the greenhouse are shown in Fig. 2. Minimum temperatures were about 2 or 3ºC higher than that outside because of heat insulation. There was a close relationship between the date of budding and the date of flowering (Fig. 3). Consequently, it was possible to predict the blooming time by using the date of budding as an index. A method using temperature, day length and bud diameter had already been developed for this purpose[4,5]. It is considered that it should be easier to adopt more direct indices from plants for practical use. Qualitative changes like budding can be easily detected at a glance.

Even in the case of the same budding day, there was about a 5-day difference in the blooming time between the cold spring of 1996 and the warm one of 1997.



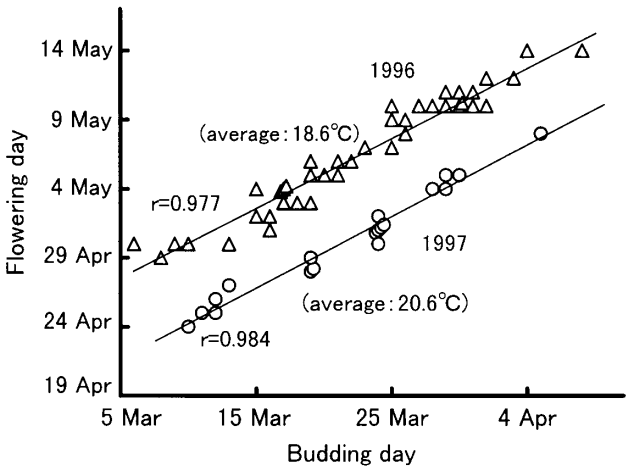


Fig. 3. Relationship between budding day and flowering day

The day of appearance of the lower bract was recorded as the budding day. Average temperatures were calculated based on maximum and minimum day temperatures from the middle of March to the beginning of May.

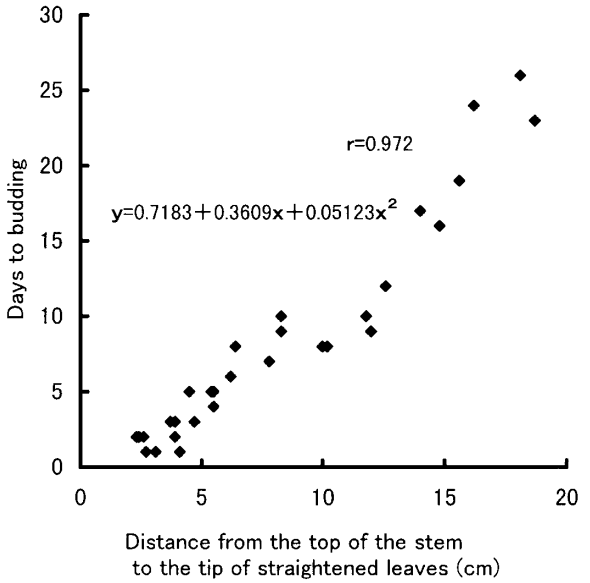


Fig. 5. Relationship between the distance from the top of the pre-budding stem to the tip of leaves and days to budding (1995)

Accordingly, heating is necessary for neutralizing the effect of the weather conditions, and to avoid cold injury.

After budding, a distinct relationship was recognized between the measurement from the tip of the bract to the apex of the calyx, and the number of days to flowering (Fig. 4) and this value could be used as an index from approximately one month before flowering. To minimize the effect of the weather conditions, and adjust the blooming peak to the intended period precisely, it is necessary to continuously predict the blooming date as it approaches. Numerical standards can be used to determine the growth status, by selecting buds with representative development from the entire shoots trained, and measuring the value to detect the difference from the desired value.

Since the distance from the top of the pre-budding stem to the tip of the leaves is closely related to the number of days until budding (Fig. 5), it was concluded that

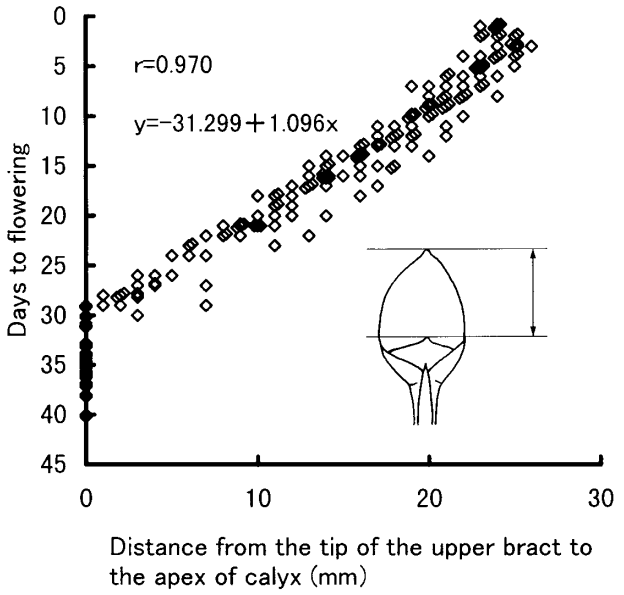


Fig. 4. Relationship between bud size and days to flowering (1995)

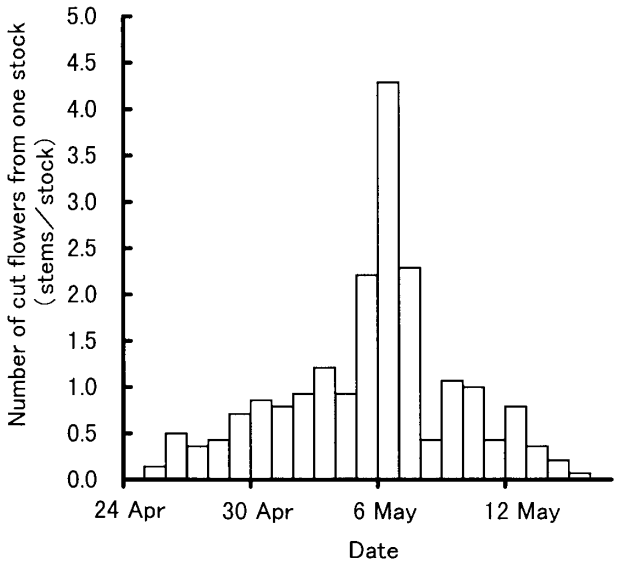


Fig. 6. Daily cut flower yield from one stock

Cut flowers with a length above 55 cm and weight above 15 g were counted (1997).

the budding date can be predicted based on this distance. Many axillary buds elongate simultaneously from winter to spring when using the DAU technique. If all the axillary buds were left until budding, overluxuriant growth and the deterioration of cut flowers may occur. Also concentration of thinning operations is not favorable for efficient labor distribution. Therefore, thinning should be initiated as early as possible, according to the prediction based on pre-budding shoots.

DAU technique induced a large peak of flowering at the beginning of May (Fig. 6). Flowering was markedly concentrated on May 6, which coincided with the demand period for Mother's Day. The yield of cut flowers per stock was about 20 stems, and about 130 stems per 1 m^2 bed area. Although the total number of cut flowers per area in a year was lower, the yield during the special period was far higher than that in the existing conventional cropping type[6,7].

2) Experiment 2: Appropriate time of the last pinching

Blooming was concentrated on May 2 and 3, and in each block more than 19 shoots per stock bloomed during the 12-day period between April 27 and May 8 (Table 1). In the plot where plants were pinched on November 12, 134 cut flowers per 1 m^2 bed area were obtained during this period. In the block where plants were pinched on October 24, the yield and cut flower weight were slightly lower. In general, the effect of the time of the last pinching on the blooming period, yield and quality was negligible, presumably due to the thinning which neutralized the effects of the treatment. As a result, it was concluded that the appropriate time of the last pinching should occur some time between the end of October and the middle of November in the warmer region of Japan.

3) Experiment 3: Suitability for long-term culture with continuously cultivated stocks

All the stocks survived throughout the summer. The day of 50% blooming in 1998 was April 28, which was earlier than the intended period (Table 1), presumably because the spring weather in 1998 was exceptionally warm. Both quality and yield exceeded those in the previous year: 30.9 cut flowers were harvested per stock, and the average length of the flowers was 73.2 cm, which was 6.7 cm longer than that in the year before. The flower quality in the third year was almost the same as that in the second year. Total yield in the third year was 40.2 cut flowers per stock, which exceeded that in the second year. However, blooming was generally delayed, because the experiment was conducted in an unheated greenhouse. Therefore, the intended temperature could not be maintained during the cold spring of 1999.

Since the harvest of cut flowers also played the role of pruning in this technique, the problems associated with long-term cultivation at present, such as labor for pruning and decrease of plant growth by pruning in summer, could be alleviated. It was found that the DAU technique was suitable for long-term cultivation, and replanting was not necessary for at least 3 years. As for fertilizer, favorable conditions had been maintained by the supply of a nutrient solution for hydroponics alone.

In this way, the initial 4 objectives were achieved. In addition, the DAU technique displays the following advantages: 1) Because of the uniformity of shoot development, optimum management can be obtained at any developmental stage; 2) Efficiency of work is improved by the reduction of supporting net layers from the usual 5 to 2; 3) The determination of a cutting point is easy,

Table 1. Effect of last pinching date and long-term culture with continuously cultivated stocks on yield and quality of cut carnation flowers

Exp. No.	Objective and treatments	Cut flower yield in each period (per stock)				Yield per bed area[a] (/m^2)	Day of 50% blooming	Cut flower	
		Onset ～ Apr 26	Apr 27 ～ May 8	May 9 ～ May 20	Total			Length (cm)	Weight (g)
2	Last pinching date								
	Oct 24	0.5	19.0	1.5	21.0	140.0	May 3	80.7	31.5
	Nov 3	1.4	19.7	1.7	22.8	152.5	May 3	78.6	34.9
	Nov 12	1.3	20.0	1.2	22.5	150.4	May 2	80.4	34.5
3	Long-term cultivation								
	First year (1997)	0.6	15.4	3.9	19.9	130.4	May 6	66.5	22.3
	Second year (1998)	8.2	22.6	0.1	30.9	187.9	Apr 28	73.2	27.3
	Third year (1999)	1.8	15.5	22.9	40.2	244.4	May 9	73.8	27.5

a): Number of stocks per 1 m^2 of bed area were 6.7 in Exp. 2, and 6.5 in Exp. 3 (6.1 in the second and third years, because of the removal of stocks which showed symptoms of virus-like disease).

because flowers are always harvested at the branching point.

On the other hand, this technique is associated with some disadvantages as follows: 1) Yearly yield from the unit area is lower than that in conventional cultivation; 2) Working hours show a remarkable seasonal trend; 3) The cultivation period of plants is restricted by contracts with traders. Except for the restriction in the period of cultivation, other disadvantages can be offset when the DAU technique is combined with the conventional cropping type.

The blooming of carnations was concentrated when they were planted from fall to winter, in which cases the plants experienced low temperatures before, and then warmer temperatures in the spring[1]. Accordingly, althogh this technique is suitable for areas where temperatures are low in winter, it could also be applied in other areas.

The DAU technique can be applied on the assumption that the price of the cut flowers in the intended period is higher than the average price. It is essential to use this technique while keeping a good balance between production and demand.

References

1) Hosoya, M. & Hayashi, K. (1977): Studies on the cropping type in the glasshouse carnations. 1. Influence of planting time in seasonal cropping system on the flowering time and flower quality. *Bull. Chiba Hortic. Exp. Stn.*, **8**, 17–26 [In Japanese with English summary].
2) Imamura, H. & Suto, K. (1997) : Prediction of flowering period and a method of cultivation of carnation for Mother's Day. *J. Jpn. Soc. Hortic. Sci*., **66** (suppl. 2), 568–569 [In Japanese].
3) Imamura, H. & Suto, K. (1998): Effects of the timing of the last pinch and the expansion of use range in concentrated flowering technique for carnations. *J. Jpn. Soc. Hortic. Sci*., **67** (suppl. 2), 431 [In Japanese].
4) Nimura, M. et al. (1996): Studies on the flowering prediction of carnation. *J. Jpn. Soc. Hortic. Sci*., **65** (suppl. 1), 426–427 [In Japanese].
5) Nimura, M. & Ito, K. (1997): Studies on the flowering prediction of carnation. 2. The relation between flower bud size and developmental index (DVI). *J. Jpn. Soc. Hortic. Sci*., **66** (suppl. 2), 566–567 [In Japanese].
6) Yamaguchi, T., Ito, A. & Koshioka, M. (1996): Effect of combination of reflective film mulching and shading treatments on the growth of carnation. *JARQ*, **30**, 181–188.
7) Yamaguchi, T., Ito, A. & Koshioka, M. (1996): Comparison of the effect of several mulching and shading materials on carnation production. *JARQ*, **30**, 189–196.