Effect of Chilling on the Induction of Rest in Strawberry Plants

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Effect of Chilling on the Induction of Rest in Strawberry Plants

Takashi NISHIZAWA* and Yutaka HORI**

**Laboratory of Horticulture, Faculty of Agriculture, University of Tokyo, Bunkyo-ku, Tokyo, 113 Japan*
***Laboratory of Horticulture, Faculty of Agriculture, Tohoku University, Sendai, 981 Japan*

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Summary

Starting on July 15 (vegetative stage), October 1 (early rest stage), and November 22 (deep rest stage), 1991, strawberry plants (*Fragaria* × *ananassa* cv. Morioka 16) were chilled at 5°C for 0, 15 and 30 days under a 14-hr photoperiod, and then forced in a growth chamber kept at day/night temperatures of 24°/22°C under a 14-hr photoperiod. The leaves which emerged during forcing were designated as L-1, L-2, L-3, etc. from the basal one and rest intensity was evaluated by their growth.

In the chilled plants, both the petiole length and lamina area were greater than in the unchilled plants irrespective of the growth stage at chilling and chilling duration, and it was especially true for L-3 to L-5. Thus, it appeared that the rest in strawberry plants might not be induced by low temperature such as 5°C under longer photoperiods.

Most strawberry cultivars enter the rest in fall in response to short-photoperiods and low-temperatures (3, 4, 6, 7). Once strawberry plants have entered the rest, the growth of new leaves was greatly inhibited even if the plants are forced under long-photoperiods and high-temperatures (8, 11, 12, 13, 14). Darrow and Waldo (4) indicated that short-photoperiods were the main cause to induce the rest of strawberry plants. On the other hand, Seyama and Takai (20) suggested that the rest of 'Donner' strawberry plants might be induced by chilling at 5°C in the dark for 20 days from October 1. Recently, Durner and Poling (5, 6) indicated that short days alone could not induce rest in strawberry plants, if flower cluster production was used as a measure of rest, while rest was induced by short days alone, if leaf production was the indicator. Thus, it is not clear if the rest of strawberry plants might be sufficiently induced by chilling under long photoperiods.

The objective of this study was to examine the possibility of rest induction

by chilling at different growth stages and different duration under a 14-hr photoperiod.

Materials and Methods

Starting on July 15 (vegetative stage), October 1 (early rest stage), and November 22 (deep rest stage), 1991 (17), 6 plants each of 'Morioka 16' strawberry plants (a cultivar with high chilling requirement for breaking rest) were chilled at 5°C for 0, 15 and 30 days under a 14-hr photoperiod, and then forced at day/night temperatures of 24°/22°C under a 14-hr photoperiod. Light in the growth chambers used for chilling and forcing was provided from 6 : 00 to 20 : 00 by 20W fluorescent lamps and 20W incandescent lamps at photosynthetic photon flux of 230 and 10 μmol m^{-2} s^{-1}, respectively, at the leaf surface. Before chilling, the axially buds were removed leaving one just below the primary cluster. Flowers and runners were removed as soon as they emerged during forcing. The first leaf which emerged during forcing were designated as L-1, and successively developed leaves were numbered as L-2, L-3, L-4, etc. The leaves from L-1 to L-5 were harvested when L-5 ceased to expand, and their growth was measured and expressed as described elsewhere (10, 19).

Results and Discussion

In the chilled plants as compared with unchilled plants, both the petiole length and lamina area of the newly-developed leaves during forcing were greater regardless of the growth stage at chilling and chilling duration, and it was especially true for L-3 to L-5 (Fig. 1). Thus, it appeared that the rest of strawberry plants was not induced by chilling under long photoperiods when measured by the growth of newly-developed leaves during forcing. On the other hand, Seyama and Takai (20) suggested that chilling in the dark for 20 days from October 1 was enough to induce the rest of 'Donner' strawberry plants. They evaluated rest intensity by the petiole length and lamina area after 2 months of forcing under the natural short photoperiods. Nishizawa and Yasukawa (18) indicated previously that the growth promotion in the newly-developed leaves during forcing reached the maximum for L-3 to L-5, but it reduced for the younger ones (L-6, L-7, etc.). Similar results were also reported by some workers (8, 14). It was probable that Seyama and Takai (20) measured the growth of L-6 to L-8 after our expression, assuming that leaf emergence interval was usually 8 to 10 days in strawberry plants (16). Then, if they measured the growth of L-3 to L-5, they might obtain a different conclusion. Moreover, they chilled the plants continuously in the dark. On the other hand, we used a 14-hr photoperiod which seemed to result in avoiding some damage of leaves and loss of stored carbo-

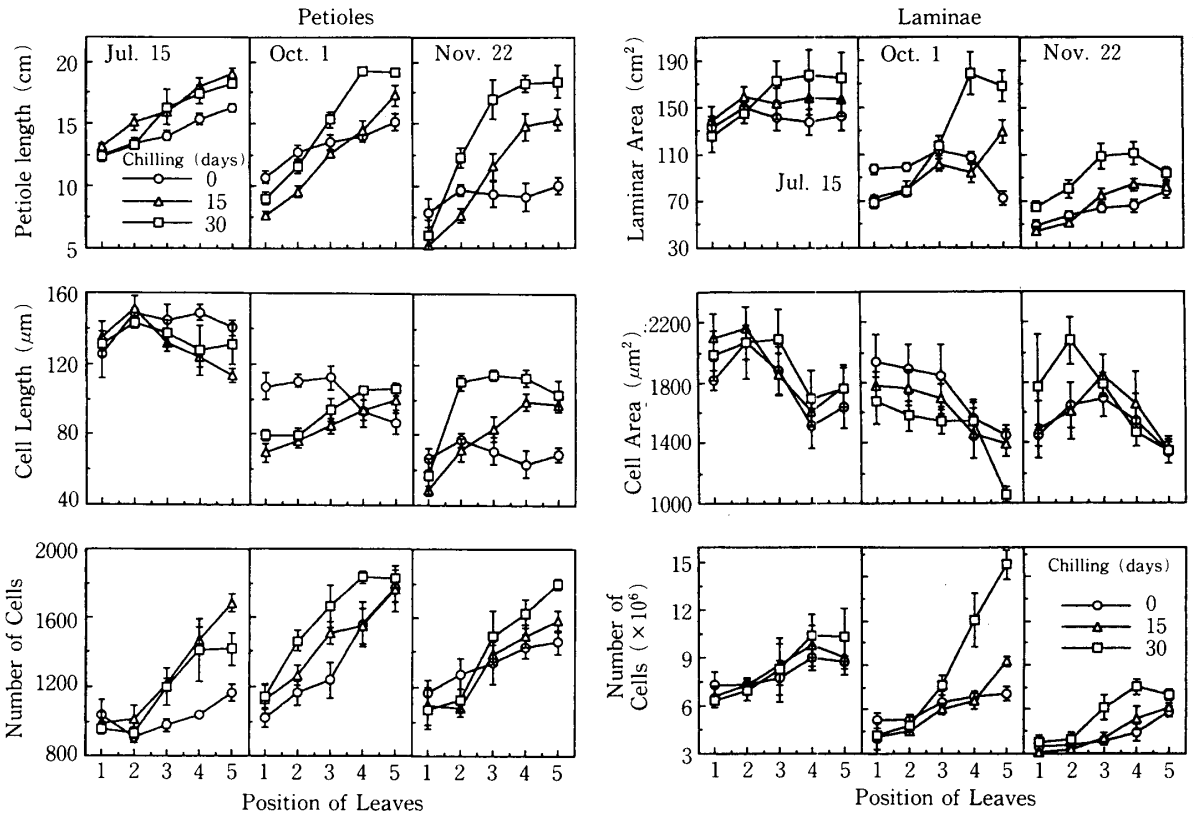

FIG. 1. Effects of chilling on petiole length, petiolar cell length, number of petiolar cells, laminar area, laminar cell area, and number of laminar cells. Starting on July 15, October 1, and November 22, plants were chilled at 5°C for 0, 15, and 30 days under a 14-hr photoperiod, and then forced at day/night temperatures of 24°/22°C under a 14-hr photoperiod. The first leaf which emerged during forcing was designated as L-1, and successively developed leaves were numbered as L-2, L-3, L-4, etc. L-1 to L-5 were harvested when L-5 ceased to expand and their growth was measured. Cell number and cell size are of epidermal cells of petioles and laminae, and values represent means of 6 plants±S.E.

hydrates which might be caused by the continuous dark. Thus, the different conclusions of these two studies might be partly due to the difference in light conditions during chilling.

In the plants chilled from July 15 as compared with unchilled plants, both the the petiole length and lamina area were greater mainly due to the increase in the number of cells. In the plants chilled from October 1 and November 22, the increase in the petiole length was mainly due to the increase in the petiolar cell length, while the increase in the lamina area was mainly due to the increase in the number of laminar cells (Fig. 2). These results confirmed the previous findings (1, 2, 9, 19) that the final length/area and number of cells in petioles and laminae of newly-developed leaves during forcing were affected by the difference in the developmental stage of leaf primordia at chilling.

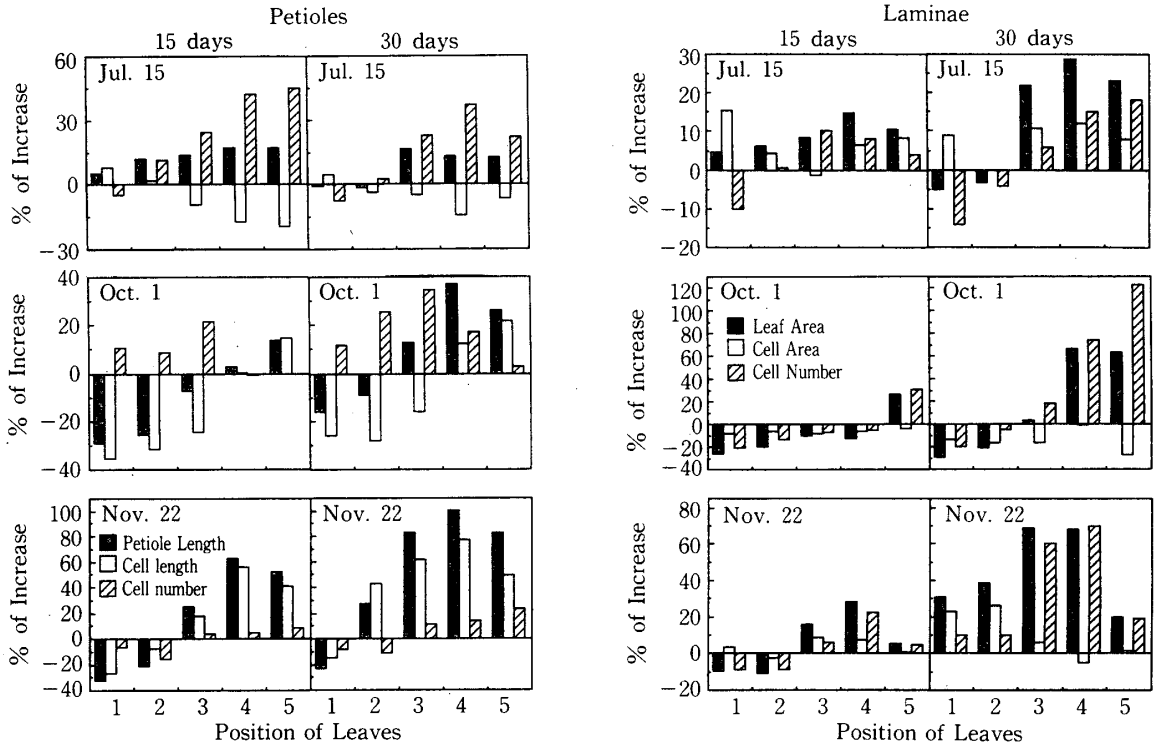

FIG. 2. Percent of increase in the petiole length, petiolar cell length, number of petiolar cells, laminar area, laminar cell area, and number of laminar cells in chilled plants over those in unchilled control plants. Calculated from Fig. 2.

The present results showed that chilling at 5°C preconditioned the leaf primordia to grow vigorously during the subsequent forcing period regardless of the plant growth stage at chilling and chilling duration.

Kronenberg and Wassenaar (12) indicated, however, that when strawberry plants were grown during fall under the natural low temperatures (perhaps above 10°C) but artificial long-photoperiods, the growth of newly-developed leaves during forcing was greatly inhibited. This result seemed to suggest that low temperatures above 10°C, instead of those below 10°C which were usually effective on breaking rest (21), might be effective for the induction of rest in strawberry plants even under long-photoperiods (15).

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