Effects of Pre-chilling and Pre- and Post-budbreak Temperature on the Subsequent Growth and Cut-flower Quality of Forced Tree Peony

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Summary

This study was undertaken to clarify the effects of pre-chilling and temperatures immediately after planting and after bud-break (growing season) on vegetative growth and cut-flower quality of tree peony 'Hanakisoi', forced early, and 'Hanakisoi' and 'Yachiyotsubaki', forced mid-season.

1. Sprouting and flower dates were advanced by pre-chilling treatment. When initial growth temperature was kept low, flowering percentage was relatively high whether the plants were pre-chilled or not. Although flowers from pre-chilled plants had fewer petals per bloom at anthesis, the expansion of leaves in these plants were good so that the cut flower form was superior to that obtained from non-pre-chilled plants.

2. When the average daily temperature during the growth period after sprouting was kept at about 17°C for 'Hanakisoi' and 'Yachiyotsubaki', the number of days from sprouting to flowering was 30 days or less. When the average temperature was reduced to about 13°C, the flowering time was delayed by 15 days, but the cut-flower quality was greatly improved in comparison with that kept at 17°C.

These results indicate that when initial growth temperature after planting was kept low, the flowering percentage became higher; when the growing temperature was kept low, cut-flower form was improved, but anthesis was delayed. Therefore, growing temperature should be regulated according to the turnover rate of crops, cropping system, and demand for cut flowers.

Introduction

Although the pre-chilling of forced tree peony for December shipping advances the sprouting and flowering dates and improves cut-flower quality (Aoki and Yoshino, 1984; Hosoki et al., 1984), it decreases flowering percentage in some cultivars (Hosoki et al., 1989). Therefore, pre-chilling treatment for forcing is not always economically advantageous.

Since December shipping is restricted by the interval between planting and shipping, some cut-flower producers tend to keep the initial growth temperature too high during cultivation. This study was undertaken to clarify the effects of pre-chilling, initial growth temperature in early-season forcing, and growing temperature for the mid-season forcing on vegetative growth and cut-flower quality. From these results, flower production systems for forced tree peony were evaluated.

Materials and Methods

Experiment 1

Two-year-old grafted tree peony 'Hanakisoi' produced in the Daisen area were used. An outline of treatments is shown in Fig. 1. The plants were divided into pre-chilled (P) and control (C) plots. Pre-chilled plants were kept at 15°C for 10 days beginning on 16 September 1987. All plants in the two plots were then chilled at 4°C for 7 weeks. On 14 November, they were transplanted in 24 cm plastic pots filled with a mixture of soil and barnyard manure (1:1, v/v) and then transferred into three growth cabinets. To test the effects of the initial growth temperature, the cabinets were set...
at the following day/night temperatures: 23°C/17°C for the high (H) treatment; 20°C/14°C for the moderate (M) temperature; and 17°C/11°C for the low (L) temperature regime. The photoperiod was 12 hr of light (1,000 lx) and 12 hr of darkness. On 24 November, all plants were transferred into a plastic film greenhouse and kept at about 18°C until they flowered (Fig. 2).

Flower-bud development, the forcing temperature (40 cm above the pot), sprouting and flowering dates, and flower quality were recorded. Diameter and length of flower buds and number of petals per flower were measured for 15 and 8 plants at the start and end of the pre-chilling treatment, respectively. Eight plants per plot were forced; the flowering date was determined to be the time when the tip of petals emerged above the sepals. The total fresh weight, stalk length and weight, flower diameter and weight, the number of petals per flower, leaf size, and stem weight of cut flower were measured at anthesis.

Experiment 2

Two-year-old grafted plants of 'Hanakisoi' produced in the Honjo area were pruned and transplanted into 24 cm plastic pots filled with the same soil mixture as above in winter, 1986. After being chilled at 4°C for 40 days beginning on 10 November 1987, the plants were placed outdoors from 20 to 31 December; they were subsequently transferred into a high (H) or a low (L) temperature room within the same plastic film greenhouse. The experimental temperature regime is noted in Fig. 3.

Two-year-old grafted plants of 'Yachiyotsubaki' produced in Daikon Island were wrapped in moist sphagnum moss and were chilled at 4°C for 42 days from 10 November to 22 December 1987. After chilling, they were potted as above and placed outdoors until 5 January 1988, when they were transferred into a plastic film greenhouse partitioned into high (H) and low (L) temperature rooms (See Fig. 3). The H room was maintained at about 17°C for 'Hanakisoi' and 'Yachiyotsubaki'; the L room was kept at 10° to 13°C for 'Hanakisoi' and 11° to 14°C for 'Yachiyotsubaki' (Fig. 4).

There were 10 plants per plot and the same parameters for flower quality as in Exp. 1 were measured.

Results

Experiment 1

During the 10-day pre-chilling period, the di-
ameter and length of flower buds became large and the number of petals per bud increased to 20 or more. However, no significant difference in flower-bud growth and development was found between pre-chilled (P) and control (C) plots, although the flower quality in the P plot was slightly superior to that of the C plot (Table 1). Budbreak was advanced by pre-chilling and by raising the initial growth temperature. The time of budbreak in the C plots was virtually constant, regardless of the initial growth temperature. As the sprouting date was advanced, so was anthesis.

Except for P-H plot which required 37 days from budbreak to flowering, the rest differed little, ranging from 30 to 32 days.

The cumulative temperature from sprouting to flowering in the H room was about 550 degree-days and the average temperature was about 18°C (Table 2).

The flowering percentage in the P-L plot was higher than that in the P-H plot. The difference in flowering percentage between C-L and C-H plots was small. The effect of initial high growth temperature resulted in a 12.5% reduction in the
flowering percentage in P-H plot.

The indices representing the degree of leaf expansion, i.e., petiol length and leaf area, tended to be larger in P plots than in C plots. However, fewer petals per blossom were present in P plots compared with flowers in the C plots. The cut-flower quality in the C-L plot was better than that in the C-H plot but that in the P-L plot was the best (Table 3).

**Experiment 2.**

In 'Hanakisoi', no difference in sprouting date was recognized between L and H plots but anthesis was 15 days earlier in the H plot. In 'Yachiyo-tsubaki', clear differences in sprouting and flowering dates were found between L and H.
plots. Budbreak and anthesis were 5 and 15 days earlier, respectively, in the H plot compared to those of the L plot. The number of degree-day from planting till sprouting in ‘Yachiyotsubaki’ was larger than that in ‘Hanakisoi’, whereas that from sprouting till flowering in ‘Hanakisoi’ was larger than that in ‘Yachiyotsubaki’ (Table 4).

Cut-flower quality in L plots was superior to that in H plots, especially in ‘Hanakisoi’ (Table 5).

Discussion

It has been shown by Hosoki et al. (1984) that the December shipping of 2-year-old grafted tree peony was feasible when the plants were chilled for about 50 days beginning about 20 September followed by from planting in pots and placing them in a heated greenhouse. In this case, a pre-chilling treatment before chilling serves not only to promote sprouting and flowering but also to increase the leaf area of cut flowers (Aoki and Yoshino, 1984; Hosoki et al., 1984). However, Hosoki et al. (1989) indicated that the pre-chilling treatment reduced the flowering percentage in some cultivars. Thus, the pre-chilling treatment is not always economically advantageous for December shipping.

In the present study, the pre-chilling treatment resulted in a significant reduction in the flowering percentage at a high initial growth temperature. When initial growth temperature was low, the frequency of blasting was low and flowering percentage of pre-chilled plants was as high as that of control (non-pre-chilled) plants. These results suggest that pre-chilling treatment advances anthesis and stimulates leaf extension, but results in a decrease in the number of petals per blossom in ‘Hanakisoi’. Thus, the cut-flower quality of pre-chilled plants was superior to that of non-pre-chilled plants. When the initial growth temperature was high, pre-chilled plants were decreased flowering percentage, in a similar manner as irises (Yoshino et al., 1977) and tulips (Aoki and Yoshino, 1983). However, no significant reduction in flowering percentage was observed in non-pre-chilled plants, even if the initial growth temperature was kept high. If growing temperature is unsuitable, flowering is delayed, and the plants will not be ready for shipping in December. Therefore, in early forcing of ‘Hanakisoi’ for the December market, the daytime temperature should be kept below 17° to 18°C between planting and budbreak and then gradually raised, and mean temperature should be maintain at 18° to 19°C until anthesis. However, it seems to be better for forcing if the daytime temperature does not exceed 25°C.

In early- or mid-season forcing of tree peony, the initial growth temperature just after planting or growing temperature after budbreak affects the time of flowering and cut-flower quality.

Flower forms at anthesis of ‘Yachiyotsubaki’ are shown in Fig. 5. The difference in cut-flower quality between low and high growing temperatures is readily seen. However, two cut flowers per plants were obtained without blasting at both temperatures. This cultivar will be useful not only for cut flower but also for pot flower. These experiments reveal that it is possible to force ‘Hanakisoi’ and ‘Yachiyotsubaki’ within 30 days after bud-break if the average daily temperature is kept about 17°C. If the average daily temperature drops by 4°C, flowering date is delayed by 15 days, but cut-flower quality is significantly improved. The growing temperature should be regulated with regard to

Table 4. Effect of growing temperature on flowering of forced tree peony.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Treatment</th>
<th>Sprouting date</th>
<th>Flowering date</th>
<th>Percentage of flowering (%)</th>
<th>Cumulative temp. (°C-day)</th>
<th>Average of temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanakisoi</td>
<td>H</td>
<td>3 Jan. b</td>
<td>31 Jan. b</td>
<td>100</td>
<td>151.8</td>
<td>629.2</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>4 Jan. b</td>
<td>15 Feb. a</td>
<td>100</td>
<td>140.2</td>
<td>667.1</td>
</tr>
<tr>
<td>Yachiyotsubaki</td>
<td>H</td>
<td>14 Jan. b</td>
<td>10 Feb. b</td>
<td>100</td>
<td>270.6</td>
<td>728.2</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>19 Jan. a</td>
<td>25 Feb. a</td>
<td>100</td>
<td>283.7</td>
<td>777.0</td>
</tr>
</tbody>
</table>

2 Growing temperature, H:High; L:Low. (Details as for Fig. 3).
3 Sprouting to flowering.
4 Different letters in columns represent significant differences, 5% level.
the turnover rate of crops, cropping system, and demand for cut flowers.

Cut-flower shipping of tree peony continues from the last 10 days of December (early forcing) to the first 10 days of May (field). The results of this study reveal that a period of 40 days, from sprouting, flowering to shipping is required. Fig. 6 illustrates an example of a cut-flower shipping system to growers to market flowers by early, middle, late, and semi-forcing per greenhouse. If two or more greenhouses are used for forcing, the picking or shipping period of cut flowers can be continuous by changing the chilling, planting, and growing temperatures.

### Table 5. Effect of growing temperature on cut-flower quality of forced tree peony.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Treatment</th>
<th>Weight of cut flower (g)</th>
<th>Length of flower stalk (cm)</th>
<th>Flower Diameter (cm)</th>
<th>Weight of petals (g)</th>
<th>Number of petals</th>
<th>Largest leaf Petiole length (cm)</th>
<th>Width (cm)</th>
<th>Length (cm)</th>
<th>Area (cm²)</th>
<th>Total leaves Weight (g)</th>
<th>Area (cm²) (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanakiso</td>
<td>H</td>
<td>79.3 b</td>
<td>39.4 b</td>
<td>18.5 b</td>
<td>29.0 b</td>
<td>60.1 a</td>
<td>13.7 b</td>
<td>27.9 b</td>
<td>33.2 b</td>
<td>252 b</td>
<td>33.6 b</td>
<td>1,342 b</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>144.5 a</td>
<td>50.1 a</td>
<td>21.7 a</td>
<td>44.4 a</td>
<td>56.8 a</td>
<td>19.7 a</td>
<td>35.4 a</td>
<td>43.6 a</td>
<td>400 a</td>
<td>67.8 a</td>
<td>2,541 a</td>
</tr>
<tr>
<td>Yachiyotsubaki</td>
<td>H</td>
<td>64.8 b</td>
<td>39.4 b</td>
<td>15.7 a</td>
<td>19.4 b</td>
<td>67.8 a</td>
<td>9.5 b</td>
<td>26.9 b</td>
<td>30.3 b</td>
<td>170 b</td>
<td>31.0 b</td>
<td>1,274 b</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>89.0 a</td>
<td>42.7 a</td>
<td>17.3 a</td>
<td>25.6 a</td>
<td>72.0 a</td>
<td>12.2 a</td>
<td>31.4 a</td>
<td>35.6 a</td>
<td>228 a</td>
<td>44.0 a</td>
<td>1,539 a</td>
</tr>
</tbody>
</table>

* Growing temperature, H: High; L: Low. (Details as for Fig. 3).

Different letters in columns represent significant differences, 5% level.

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**Fig. 5.** Representative flower form of 'Yachiyotsubaki' at anthesis. Left: Low growing temperature. Right: High growing temperature.

**Fig. 6.** Cut-flower production systems of tree peony. ●: Chilling; ○: Planting; ○: Heeling-in; △: Transfer to plastic film greenhouse (heated); ●: Transfer to plastic film greenhouse (non-heated); □: Flowering and shipping.
Literature Cited


予備冷蔵と生育初期温度ならびに栽培温度が促成ポタンの生育と切り花形質に及ぼす影響

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摘　要

予備冷蔵の有無と生育初期温度（'花期'）ならびに栽培温度（'花期', '八千代桜'）が促成ポタンの生育と切り花形質に及ぼす影響について調査した。

1. 予備冷蔵処理の各区は、対照区の各区に比べ、ほう芽期や開花期が促進した。予備冷蔵処理区で生育初期温度が高いためには、開花率が著しく低下した。しかし生育初期温度が低い場合、予備冷蔵処理区も対照区と同様に開花率は高いかった。予備冷蔵処理によって、開花期の花弁数が減少する傾向であったものの、葉の展開は良好で草姿が優れた。

2. 中期促成において、ほう芽から開花までの平均温度が17℃前後のとき、「花期」、「八千代桜」の両品種とも30日以内で開花した。平均温度が4℃下がれば15日間の開花遅延が生ずるもの、切り花品質は著しく向上した。

以上の結果から、栽培温度が低ければ開花率や切り花品質は向上するものの、開花日は遅延する。したがって栽培温度は後作や需要との関連で決定すべきであろう。