予備冷蔵及び薬剤処理によるボタンの12月促成開花

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Forcing of Tree Peony for December Shipping by Pre-chilling and Chemical Treatments[1]

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Summary

Forcing methods of tree peony (*Paeonia suffruticosa*) timed for New Years Day were investigated. Garlic paste applied to the flower bud after chilling promoted bud sprouting and leaf extension. This treatment also accelerated flowering, advancing harvest time to the middle of December. Pre-chilling treatment had a similar effect on flowering although the effectiveness depended on the cultivar. A combination treatment of pre-chilling and garlic paste resulted in flowering at the end of November when applied to a cultivar in which dormancy was less deep.

Introduction

Commercial growers of tree peony have recently focused on production of cut and pot flowers rather than garden nursery plants, since the demand for graden plants is not increasing among consumers, due to changes in housing conditions.

Forcing from January to April has been practiced, with few problems, whereas forcing in December timed for New Years Day is not yet commercially successful, since tree peony has deep dormancy which brings about problems such as lack of sprouting, blasting of flower bud or poor develoment of leaves. In a previous experiment (5), gas treatments such as ethylene, nitorgen or ethanol promoted leaf exetension as well as sprouting of the flower bud when the chilling period was not long enough. Although these treatments enabled to flower in December, the flowering rate was still lower than 80%, the base limit for commercial production.

This report describes successful forcing methods for December shipping by pre-chilling and garlic patste treatments.

Materials and Methods

Two year-old grafted plants were used for all the experiments with 6 plants per treatment.

The treated plants were planted in pots (ϕ 24 cm) containing soil medium mixed with 20% manure and cultured in a heated glasshouse with minimum temperature of 16°C. Average values of daily minimum, maximum and mean temperatures were calculated at ten day intervals and are shown in Fig. 1. The harvest date was determined when the top of the petals just appeared from the calyx. Length of flower stalk, flower diameter and leaf size (refer to Fig. 2) were measured at anthesis.

Experiment 1. *Effect of garlic paste treatment*

Plants of 'Taiyo' were dug up on Sept. 22, 1983 and the leaves removed. The roots were then wrapped with moist sphagnum moss and the whole plants were chilled at 3°C for 50 days. On November 11, they were planted in pots and cultured in the glasshouse. Half of the plants were treated with garlic paste which was applied around flower buds, left for 20 hours and then removed. A similar experiment was conducted on plants dug up on October 1 where the chilling period was shortened to 40 days, hence the planting date was November 10.

Experiment 2. *Effect of pre-chilling treatment*

Plants of 'Taiyo', 'Hanakisoi' and 'Tamasudare' were dug up on August 23, 1983. The roots were then wrapped with moist sphagnum moss and the whole plants pre-chilled at 10°C or 15°C for 20 days or at 15°C

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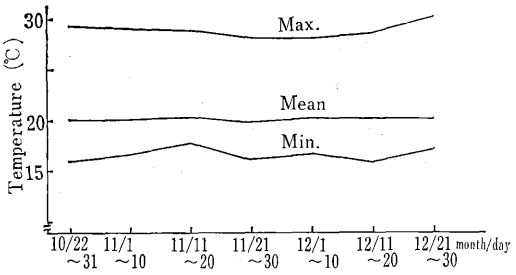

Fig. 1. Maximum, minimum and mean temperatures in a heated glasshouse (averages of ten day interval).

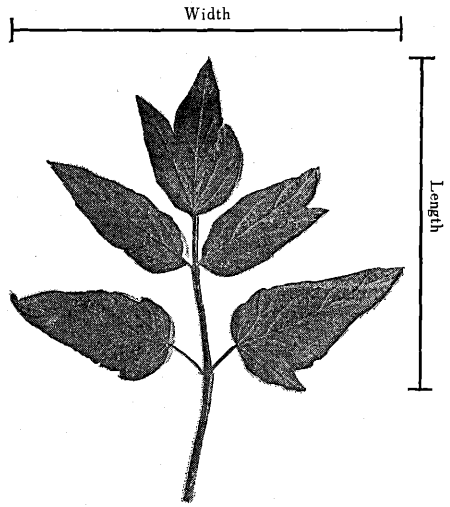

Fig. 2. Criterion of leaf size.

for the first 10 days followed by 10°C for the second 10 days. On September 13, all pre-chilled plants were exposed to chilling at 3°C for 49 days and were planted on November 1. For the control, plants were dug up on September 12 and chilled at 3°C for 49 days from Septmber 13.

Experiment 3. *Flowering in November by a combination of pre-chilling and garlic paste treatment*

Plants of 'Taiyo' were dug up on August 23, 1983, pre-chilled at 10°C for 20 days and then chilled at 3°C for 39 days. Half of them were then treated with garlic paste in the same method as Experiment 1. Five plants per treatment were used in this experiment.

Results

Experiment 1. *Effect of garlic paste treatment*

Garlic paste treatment considerably promoted sprouting in plants chilled for 40 days, although there was little promotion in those chilled for 50 days (Fig. 3). A chilling period of 50 days greatly promoted sprouting. Over 80% of flowers reached harvestable stage by December 26 with garlic paste treatment after 40 day chilling or with/without garlic paste treatment after 50 day chilling (Table 1). The cumulative temperatures (degree · day) from planting to harvest were less in the treatments where the sprouting occurred earlier. The length of flower stalks in the 40 day chilling treatment without garlic paste were slightly shorter than those in the other treatments. Flower diameter was almost the same in all the teratments, leaf extension was promoted with garlic paste treatment, the effect being greater for plants with 40 day chilling (Figs. 4 and 5).

Experiment 2. *Effect of pre-chilling treatment*

For 'Taiyo', any pre-chilling treatment promoted sprouting and shortened the time to harvest date. Thus, the cumulative temperatures from planting to harvest in pre-chilled plants were less than those in control plants (Table 2). All of the plants with and without pre-chilling reached harvestable stage by December 19. Length of flower stalks and flower diameters were simiar in all treatments. Leaf extension was greatly promoted by any pre-chilling treatment whereas that remained very poor in control plants (Fig. 6).

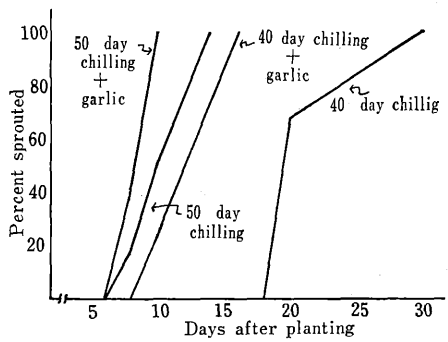

Fig. 3. Effect of chilling period and garlic paste treatments on sprouting ('Taiyo').

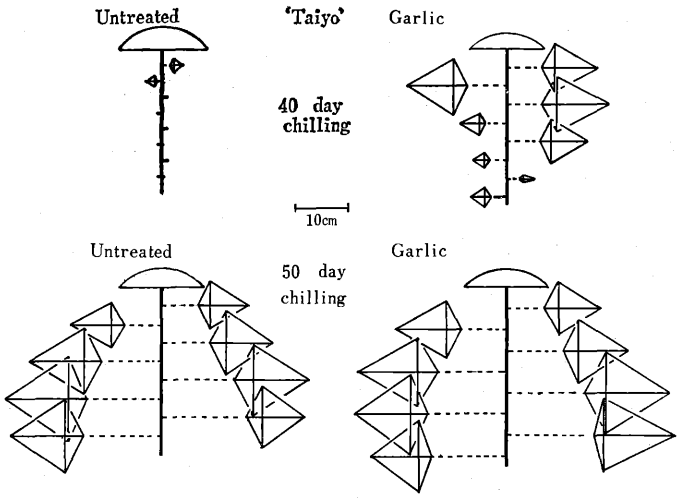

Fig. 4. Effect of chilling period and garlic paste treatments on leaf extension ('Taiyo').

Table 1. Effect of chilling period and garlic paste treatments on sprouting and flowering ('Taiyo').

Chilling period (days)	Garlic paste treatment	Sprouting date (month/day)	Harvest date[z] (month/day)	Cumulative temp. from planting to harvest	Rate of harvested flowers (%) Dec/26	Jan/2	Length of flower stalk (cm)	Flower diameter (cm)
40	−	12/2	12/24	893	67	100	25.5	16.6
	+	11/23	12/17	752	83	83	29.9	14.8
50	−	11/22	12/17	729	100	—	31.7	15.5
	+	11/20	12/16	711	100	—	34.0	16.0

[z] Harvested flowers only.

Table 2. Effect of different pre-chilling temperatures on sprouting and flowering.

Cultivar	Temp. of pre-chilling[z]	Sprouting date (month/day)	Sprouting rate (%)	Harvest date[y] (month/day)	Cumulative temp. from planting to harvest	Rate of harvested flowers (%) Dec/26	Jan/2	Length of flower stalk (cm)	Flower diameter (cm)
'Taiyo'	Untreated	11/19	100	12/13	861	100	—	25.3	17.0
	10°C	11/16	100	12/9	783	100	—	26.3	16.8
	15°C	11/14	100	12/7	742	100	—	26.8	13.2
	15—10°C	11/15	100	12/8	762	100	—	26.6	14.8
'Hanakisoi'	Untreated	11/16	100	12/10	802	100	—	25.8	16.3
	10°C	11/17	100	12/9	783	100	—	23.5	17.9
	15°C	11/14	100	12/7	742	100	—	29.0	16.3
	15—10°C	11/14	100	12/6	722	83	83	26.8	16.2
'Tamasudare'	Untreated	11/28	17	12/25	1102	17	17	22.5	13.0
	10°C	11/26	83	12/17	941	67	83	22.4	16.5
	15°C	11/26	50	12/13	861	33	33	22.8	14.0
	15—10°C	11/28	83	12/20	1004	50	67	22.9	16.3

[z] After pre-chilling for 20 days, chilling at 3°C for 49 days was given to all the plants.
[y] Harvested flowers only.

For 'Hanakisoi', pre-chilling at 15°C or 15—10°C also accelerated sprouting and advanced the harvest date, although pre-chilling at 10°C had little effect. Length of flower stalk and flower diameter were nearly the same in all the treatments. Leaf extension was promoted by 15°C or 15°—10°C pre-chilling treatment but not by 10°C nor non pre-chill-

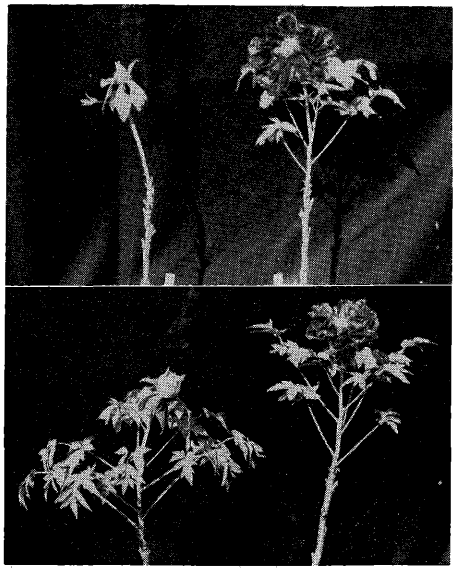

Fig. 5. Effect of chilling period and garlic paste treatments on flowering ('Taiyo', photographed on December 20).
Upper : 40 day chilling (left), 40 day chilling+ garlic (right).
Lower : 50 day chilling (left), 50 day chilling+ garlic (right).

ing control (Figs. 7 and 8).

For 'Tamasudare', sprouting in non pre-chilled plants was very slow compared with the other cultivars. Although pre-chilling promoted sprouting, the effect was not complete enough to give release from dormancy, and the harvest date was delayed in all the treatments. Thus, cumulative temperatures were very high. The highest rate of harvestable flowers by December 26 was 67% (10°C pre-chilling treatment). Lengths of flower stalk and flower diameter were similar to all the treatments. Leaf extension was promoted by 10°C or 15—10°C pre-chilling treatment but petiole elongation was still poor (Fig. 9).

Experiment 3. *Flowering in November by a combination of pre-chilling and garlic paste treatment*

In 'Taiyo', pre-chilling treatment or a combination of pre-chilling and garlic paste resulted in a harvest time at the end of November ; harvesting was completed by December 3 (Table 3). Sprouting date and rate, harvest date and cumulative temperatures were almost the same between the two treatments. Leaf extension was considerable in the combination treatment although it was already large enough in the pre-chilling only treatment.

Discussion

Forcing of tree peony has been practiced among tree peony growers who have used chilling treatments to give release from dormancy. However, flowering in December is very erratic and frequently accompanied by

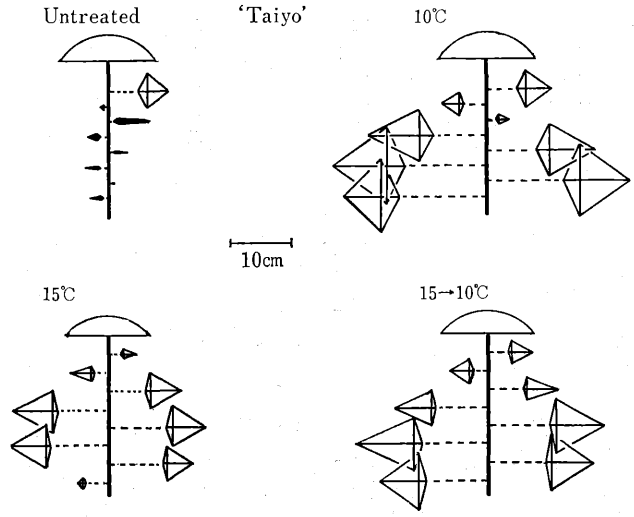

Fig. 6. Effect of different pre-chilling temperatures on leaf extension ('Taiyo').

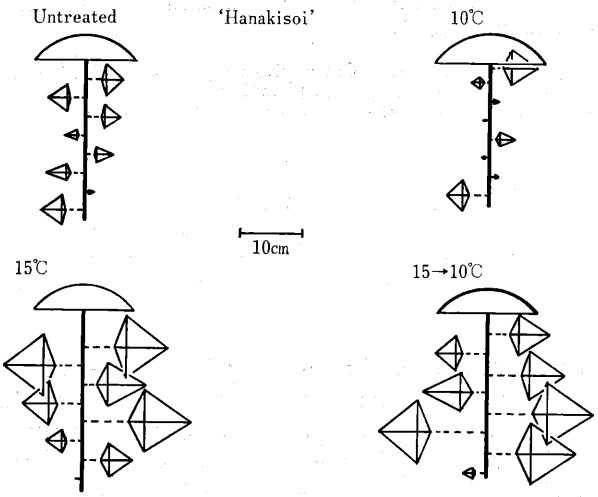

Fig. 7. Effect of different pre-chilling temperatures on leaf extension ('Hanakisoi').

Fig. 8. Flowering of 'Hanakisoi' with different pre-chilling temperatures (photographed on December 9).
From left to right : Control, 10°C pre-chilling, 15°C pre-chilling and 15—10°C pre-chilling.

lack of sprouting, poor development of leaves or blasting of the flower bud. Although chilling from October may insure complete release from dormancy, the flowering time is often delayed until January at whcih time the flowers do not retail at high price (1, 7). As is often observed by the growers, an early start of chilling from late August brings about blasting or poor development of leaves. Blasting may be induced by insufficient accumulation of nutrients into buds, by digging time or because the flower bud is still at too early

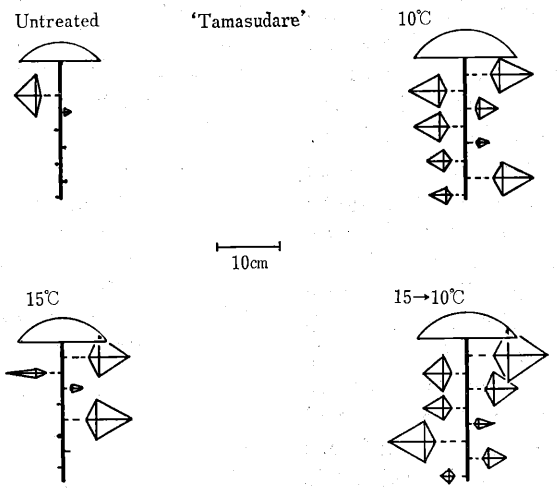

Fig. 9. Effect of different pre-chilling temperatures on leaf extension ('Tamasudare').

Table 3. Effect of combination treatment of pre-chilling and garlic paste on sprouting, flowering and leaf extension ('Taiyo').

Treatment[z]	Sprouting date (month/day)	Sprouting rate (%)	Harvest date[y] (month/day)	Cumulative temp. from plannting to harvest	Rate of harvested flowers (%) (Dec/3)	Length of flower stalk[y] (cm)	Flower diamter (cm)	Leaf size[x] (4 th node) L×W (cm)
Pre-chilling only	11/6	100	11/30	798	100	27.2	13.9	7.9×7.9
Pre-chilling +garlic	11/4	100	11/30	798	80	23.5	12.8	9.8×11.0

[z] After pre-chilling at 10°C for 20 days, chilling at 3°C for 39 days was given to all the plants.
[y] Harvested flowers only.
[x] Refer to Fig. 2.

a stage of development in late August (beginning of petal formation stage) to respond to low temperature as recognized in peach(2). Poor development of leaves was observed when there was incomplete release from dormancy, but in 'Taiyo' this problem was dissolved by extending the chilling period to 50 days (Ex. 1). The same chilling period was, however, still not long enough to release leaves from dormancy in plants dug up earlier (on Septmber 12). Since the cumulative temperatures from planting to sprouting were greater in the plants dug up earlier than the cumulative temperatures in those dug up later (on September 22), the depth of leaf dormancy seems to be correlated with depth of bud dormancy.

Pre-chilling treatment generally promoted bud sprouting as well as leaf extension. For ornamental trees in which development of flower buds proceeds in autumn, cooling often accelerates these development(3). Therefore, cooling might have had the same effect on tree peony, although a microscopic study must be completed to test this supposition. Goi(4) recognized that dormancy in peach became less deep as the floral stage progressed even if low temperatures below 15°C were not given. Pre-chilling might have had a similar dormancy-releasing effect on tree peony through acceleration of flower bud development, thus aged tissues, including leaf, became more responsive to low temperature. Optimum pre-chilling temperature for bud sprouting and leaf extension was different among cultivars, and numbers of floral petals were generally less in pre-chilled plants than those in non pre-chilled plants. Therefore, optimum pre-chilling temperatures and starting date (i.e. digging date of plants) must be further investigated with each cultivar.

Garlic paste treatment was, as reported before(5), very effective for releasing flower buds and leaves from dormancy and showed little phytotoxicity. Kubota *et al.*(8) also recognized that garlic paste promoted sprouting from dormant grape when administered to pruned canes. Therefore, such a treatment could become an useful method together with ethylene, nitrogen or hot water(5)when an ample period of chilling could not be afforded or when cultivars with deep dormancy were selected for forcing. Although the active substances in garlic and its mechanism of action are under investigation, allyl sulfide, which promoted respiration, may be involved in release from dormancy(6).

For forcing before December, a combination treatment of pre-chilling and garlic was very effective for 'Taiyo'. This method should be tested in other cultivars as well as the selection of cultivars towards shallower dormancy.

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予備冷蔵及び薬剤処理によるボタンの12月促成開花

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摘　要

正月出荷を目的としたボタン（*Paeonia suffruticosa*）の促成開花が試みられた．冷蔵後の花芽にニンニクペーストを処理すると，萌芽と葉の伸展が促進された．また，同処理により開花も早められ，12月中旬の収穫が可能であった．予備冷蔵処理でも，同様な開花促進効果がみられたが，品種により効果の程度は異なっていた．休眠の浅い品種を用いると，予備冷蔵とニンニクの併用処理により11月下旬の開花が可能であった．