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Studies on the Forcing of Tree Paeony (*Paeonia suffruticosa* Andr.)

(4) Effects of Shading and Daylength Treatments during Summer on the Growth and Development of Flower Buds and Cut-Flower Quality of Forced Tree Paeony

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ボタンの促成に関する研究（第4報）
夏の遮光および日長処理が花芽の発育および促成ボタンの
切り花形質に及ぼす影響
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We have investigated to clarify the effects of shading and daylength treatments during summer on the growth and development of flower buds and cut-flower quality of forced tree paeony.

A few sepals were observed at the start of treatments. Shading treatment decreased solar light intensity and lowered growing temperature, and consequently, accelerated flower-bud differentiation. The number of petals for shading plot (S) was larger than that of control one (C) at the end of treatments. Difference in petal number was also observed for daylength treatments. The growth of plants in SD (25 °C, short daylength (8 hours, 10,000 lx)) plot was more advanced than that in LD (25 °C, long daylength (16 hours, 10,000 lx)) plot.

The number of days from emergence to flowering was 31 days in all plots. Flowering percentages were 90 % for LD plot and 78 % for the C and S plots.

Cut-flower quality at anthesis for LD plot was excellent. Flower weight and cut-flower weight for C and S plots were inferior to those for LD and SD plots. The number of petals for C plot was the least. No close relation was observed between flower diameter and petal number or flower weight.

Flower buds for plants produced in Daisen tended to be more advanced than those produced in Matsue. The petal number of cut flower with prechilling (C, S, LD and SD plots) was less than that without prechilling (plants produced in Daisen), though leaf area of cut flower was larger for the former than that for the latter.

Introduction

The growth and development of flower bud after the initiation of flower bud are

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closely related to summer ambient temperature and are promoted, in general, by lower temperature. It has been suggested that the growth stage of flower bud has influence on the flowering percentage and cut-flower quality of forced tree paeony (1).

To clarify this point in detail, we have investigated the effects of shading and daylength treatments of the plants after flower-bud initiation on the growth and development of flower bud and cut-flower quality of forced tree paeony.

Furthermore, we have investigated the growth of flower bud and cut-flower quality of forced tree paeony produced in Daisen area.

Materials and Methods

One-year-old grafted plants 'Hanakisoi' were pruned and then planted in 24 cm plastic pots filled with soil and barnyard manure (1 : 1 vol) on December 7, 1985 in Matsue. These plants were cultivated with normal management practices until July 25, 1986; treatments were commenced on July 26 (Fig. 1).

The treatments plots were as follows: in the field (C) from December 7, 1985; shading (S) by double cheesecloth in the field; long day (LD) at 25 °C, 16 hours daylength (10,000 lx/day); short day (SD) at 25 °C, 8 hours daylength (10,000 lx/day).

All plants were precooled at 15 °C from September 5 for 21 days and then chilled at 4 °C from September 26 for 45 days in the pots of moist soil. Forcing was commenced on November 11 in a heated plastic greenhouse. There were 9 plants in the C or S treatments and 10 plants for LD and SD treatments. Only 10 plants cultivated in Daisen were wrapped in moist sphagnum moss and then chilled at 4 °C

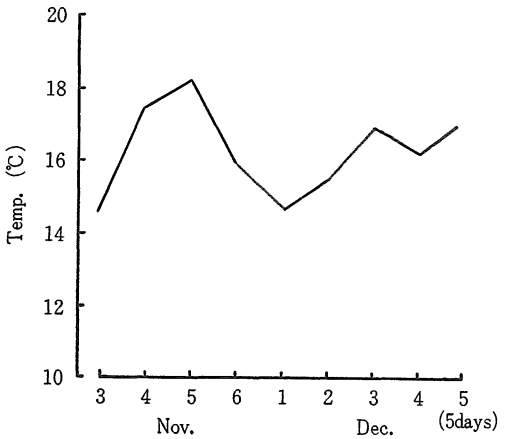

Fig 2. Changes in growing house temperature (means of every 5 days) during forcing as measured at 40 cm above the pots.

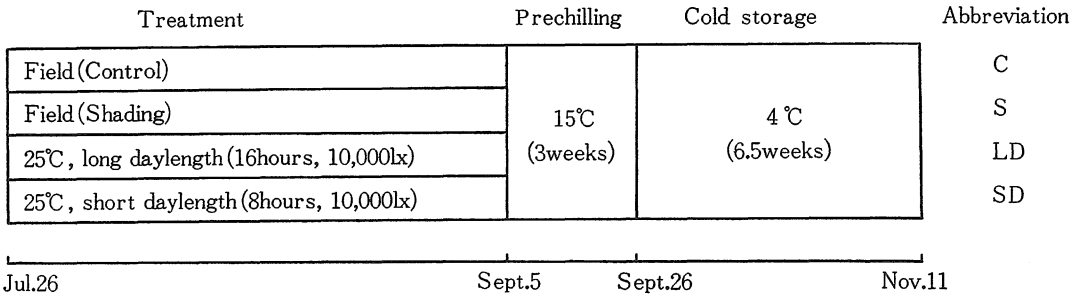

Fig 1. The outline of experimental treatments.

from September 30 for 45 days. Forcing was commenced on November 14 in a heated plastic greenhouse.

Flower-bud growth, solar light intensity, forcing temperature (40 cm above the pot) and shoot emergence and flowering dates, as well as flower quality of forced tree paeony, were recorded.

Flower buds of 5 plants were measured before and after the treatments.

The forcing temperatures (mean of every 5 days) were controlled about 14°～18°C from planting to flowering (Fig. 2).

Flowering date was determined to be the time when the top of petals just appeared from the sepal. Cut-flower weight, flower stem lengths, flower diameters and weights, petal number, leaf size and stem weights were measured at anthesis.

Results and Discussion

Solar light intensity gradually increased after sunrise and reached the maximum about 12 o'clock in a day. In the case of C plot, it exceeded 100,000 lx at the maximum. Shading treatment, however, lowered light intensity: the intensity for S plot was less than 40,000 lx even at the maximum, and it was always about 1/3 that for C plot (Fig. 3).

The difference of light intensity influenced temperature around cultivating plants. Temperature (means of every 5 days) for S plot was 0.6°～0.9°C lower than that for C plot. The mean temperatures during treatment period were 26.0° and 25.3°C for the C and S plot, respectively (Fig. 4).

On July 26 when we commenced our research, no petals were observed, though a few sepals were present. The growth of flower buds at the end of treatments was affected by shading or daylength. Namely, the growth of flower buds in the S and SD

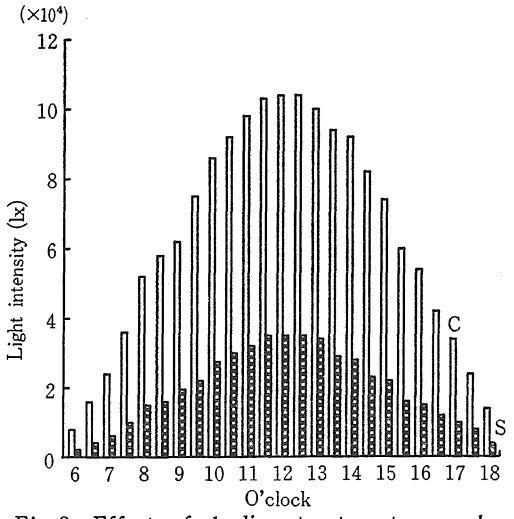

Fig 3. Effect of shading treatment on solar light intensity. (Shown on Jul. 29, 1986)
As to symbols, refer to Fig. 1.

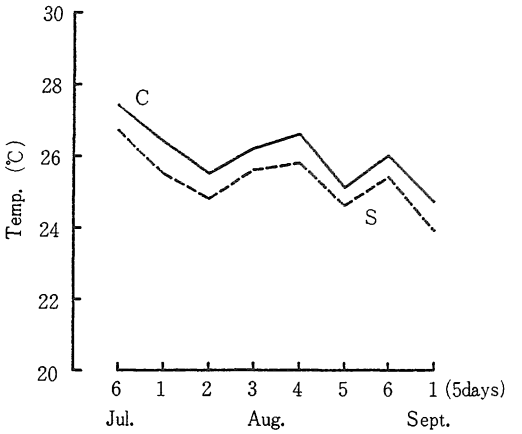

Fig 4. Effect of shading treatment on temperature (means of every 5 days) around plants during summer as measured at 40 cm above the pots.
As to symbols, refer to Fig. 1.

Table 1. Effect of field conditions during the summer of 1986 on the development of tree paeony (*Paeonia suffruticosa* Andr.) flower buds.

Sampling date	Treatment[z]	Bud		Flower bud[y]		Flower		Number of petals
		Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)	
Jul. 26, 1986[x]		6.8	12.3	2.5	2.9	—[u]	—	—
Sept. 5, 1986[w]	C	7.0a[v]	13.3a	2.9ab	3.6ab	0.8b	1.0a	4.4b
	S	7.1a	14.0a	3.0a	3.7a	1.2a	1.3a	8.9a
	LD	7.0a	13.4a	2.5b	3.2b	0.9ab	1.1a	5.0b
	SD	7.2a	13.3a	2.6b	3.3ab	1.0ab	1.2a	8.0ab

[z] C : control, cultivated in the field ; S : shading, cultivated in the field ; LD : Long day at 25 °C, 16 hours daylength (10,000 lx/day) ; SD : short day at 25 °C, 8 hours daylength (10,000 lx/day).
[y] Measured after removing scales.
[x] At the start of treatment.
[w] At the start of prechilling (at the end of treatment).
[v] Mean of 5 plants, separated by Duncan's multiple range test, 5 % level.
[u] No differentiation of petals was observed, but a few sepals were observed.

Table 2. Effect of field conditions during the summer of 1986 on bud elongation and flowering of forced tree paeony plants.

Treatment[z]	Sprouting date	Flowering date	Cumulative temp.		Rate of flowering (%)
			Planting to sprouting (°C·day)	Sprouting to flowering (°C·day)	
C	Nov. 20ab[y]	Dec. 21a[x]	143.5	500.1	78
S	Nov. 20b	Dec. 21a	143.5	500.1	78
LD	Nov. 20ab	Dec. 21a	143.5	500.1	90
SD	Nov. 19a	Dec. 20a	125.3	504.0	80

[z] Treatment conditions as in Table 1.
[y,x] Mean of sprouted or flowered plants, separated by Duncan's multiple range test, 5 % level.

Table 3. Effect of field conditions during the summer of 1986 on the quality of cut flowers from forced tree paeony plants.

Treatment[z]	Weight of cut flower (g)	Length of flower stalk (cm)	Flower		Number of petals	Largest leaf			Total leaves		Weight of stem (g)
			Diameter (cm)	Weight (g)		Petiole length (cm)	Width (cm)	Length (cm)	Weight (g)	Area (cm^2)	
C	64.6b[y]	44.0a	18.4a	21.9b	29.3b	15.3a	26.0a	32.6a	28.2a	1,186a	14.5a
S	62.6b	44.5a	16.8a	21.8b	36.6a	13.9b	24.8a	30.5a	25.5a	1,114a	15.2a
LD	78.4a	46.1a	17.8a	27.8a	38.7a	16.1a	28.0a	34.4a	32.5a	1,290a	18.1a
SD	69.7ab	46.9a	18.5a	27.7a	44.8a	15.9a	26.8a	33.4a	26.0a	1,077a	16.0a

[z] Treatment conditions as in Table 1.
[y] Mean of flowered plants, separated by Duncan's multiple range test, 5 % level.

Table 4. Development of flower buds in tree paeony plants produced in Daisen.

Sampling date	Bud		Flower bud		Flower		Number of petals
	Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)	Diameter (mm)	Length (mm)	
Sept. 8, 1986	9.4	17.4	3.6	4.3	1.2	1.5	10.6
Sept. 30, 1986[z]	10.0	19.9	4.1	5.8	2.1	2.5	25.3

[z] At the start of chilling.

Table 5. Bud elongation and flowering of forced tree paeony plants produced in Daisen.

Sprouting date	Flowering date	Cumulative temperature		Rate of flowering (%)
		Planting to sprouting (°C·day)	Sprouting to flowering (°C·day)	
Nov. 29	Dec. 30	254.8	505.5	90

Table 6. Cut-flower quality of forced tree paeony plants produced in Daisen.

Weight of cut flower (g)	Length of flower stalk (cm)	Flower		Number of petals	Largest leaf			Total leaves		Weight of stem (g)
		Diameter (cm)	Weight (g)		Petiole length (cm)	Width (cm)	Length (cm)	Weight (g)	Area (cm^2)	
42.4	34.2	15.5	20.3	78.6	8.1	16.3	21.3	12.9	583	9.3

plots had been more advanced than those in the C and LD plots, respectively (Table 1). It was shown that flower-bud differentiation is promoted by lowering temperatures after flower-bud initiation (1). Therefore, the fact that the S plot was more advantageous for the growth of flower buds than C plot may be attributed to the temperatures for the former being lower than those for the C plot.

On the other hand, the petal number of LD plot suggested that long daylength during summer does not always influence effectively the growth of flower bud. Namely, it seems that long daylength and strong light intensity are not always needed for plants after flower-bud initiation.

The emergence and flowering of plants for SD plot tended to be faster than those for the other plots. The number of days from emergence to flowering was 31 days in all plots, and the cumulative degree-day temperature was about 500 °C. Flowering percentages were the highest (90 %) in LD plot, and the lowest (78 %) in the C and S plots (Table 2).

Cut-flower quality at anthesis was excellent for LD ; weight of cut flower, flower weight, weight and area of total leaves and stem weight tended to be larger than those for the other plots, and flowers from the C and S plots were poor (Table 3).

Terminal buds for plants produced in Daisen tended to be more advanced than those in Matsue (Table 4).

Although the number of days from planting to flowering was 46 days which was longer than that for prechilling plots by 6 days, the number of days from emergence to flowering was 31 days and the cumulative degree-day temperature was about

500°C. The fact indicates that the number of days from emergence to flowering is constant, regardless of prechilling (Table 5).

The plants without prechilling gave larger petal number, smaller leaf area, and worse cut-flower quality than those with prechilling (C, S, LD and SD plots) at anthesis (Table 6).

It is well known that bulbous plants from various production regions differ from one another in the growth of flower bud, flowering time and cut-flower quality. Thus, it is reasonable to consider that the growth and development of flower buds in tree paeony are also affected by production region of plants. Furthermore, it has been reported that cut-flower quality of forced plants is also affected by the growth of flower bud (1). The present investigation showed that the flower formation of plants grown in Daisen is promoted rather than that in Matsue, whereas the cut-flower quality of plants produced in Daisen is inferior to that in Matsue. In case of tree paeony plants produced in Daisen region, the plants without prechilling were wrapped in moist sphagnum moss and roots were somewhat injured during cold storage. This may be reason why stem and leaf area of cut flower are inferior in the plants grown in Daisen to those in Matsue.

Hosoki *et al* (2) and Aoki and Yoshino (3) reported that prechilling treatment accelerates emergence and flowering time and increases cut-flower leaf area. The results of this investigation agreed with those of previous reports (2, 3). Thus, it was reconfirmed that prechilling treatment accelerates the stage of flower formation, promotes emergence and flowering time, increases cut-flower leaf area, and decreases petal number.

It was also revealed that long daylength and strong solar illumination in summer is not always necessary for flower-bud growth of tree paeony and it is desirable to promoto flower-bud formation by shading the plants in field during summer.

Judging from cut-flower quality of forced tree paeony, however, there is no close relationship between the growth of flower bud and plant substantiality. It is necessary to study flower-bud substantiality from the viewpoint of plant nutrient.

References

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摘　　要

夏の遮光と日長処理がボタン花芽の発育と促成切り花に及ぼす影響について調査した.

処理開始時には，二，三のがく片のみが観察された．遮光処理によって日照量が減少し，栽培温度が下がった．その結果，花芽形成が促進し，処理終了時には，遮光区の花弁数は対照区の花弁数より多かった．日長処理についても花弁数の差が生じ，短日処理区は長日処理区より勝った．

発芽から開花までの日数は，全処理区とも31日であった．開花率は長日処理区が90%で最も高く，対照区と遮光区は78%であった．

開花時における切り花形質は長日処理区が優れた．対照区や遮光区の花重量や切り花重は，長日処理区や短日処理区に比べ劣った．また対照区の花弁数は最も少なかった．花の直径と花弁数あるいは花重量との相関関係は低かった．

大山地方で生産されたボタンの花芽は，松江産に比べ進んでいる傾向があった．予備冷蔵処理の各区は，本冷蔵処理のみの大山産に比べ，切り花の花弁数では劣ったが，葉面積では優れた．