Effects of Duration and Temperature in Simulated Dark Shipping on the Subsequent Performance of the Nobile-type Dendrobiums

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Abstract. The popularity of the nobile-type dendrobium (Dendrobium nobile hybrids) has been increasing globally. More information regarding the effects of long-distance shipping, from producing countries to destination market countries, on the post-shipping plant performance is needed. In this study, two nobile-type dendrobium cultivars were subjected to simulated dark shipping (SDS) at various temperatures and durations. Changes in net CO2 uptake rate (Pn), chlorophyll fluorescence, and leaf relative water content after plants had been treated with SDS were investigated. Furthermore, shipped plants were vernalized to investigate the effect of dark shipping on the subsequent flowering quality. Dark shipping for 7 days at 15 °C did not affect the post-shipping photosynthetic performance of D. Lan Tarn Beauty. Increasing the shipping duration from 7 to 21 days increased the time required for Pn recovery from 1 to 12 days. Dendrobium Lan Tarn Beauty recovered its Pn within 4 days when shipped for 21 days at 10 °C, and this was prolonged to 11 days when the plants were shipped at 20 °C. Changes in Fv/Fm indicated that there was no marked damage to either cultivars, and the leaf relative water content was little affected by SDS. Dendrobium Lan Tarn Beauty and D. Lucky Girl shipped at 10 °C flowered 5 and 8 days earlier, respectively, compared with nonshipped plants. Regardless of the shipping conditions, shipped D. Lucky Girl had a lower flower diameter and higher total flower count than nonshipped plants. No differences were found in the number of nodes with flowers or the total flower count between shipped and nonshipped D. Lan Tarn Beauty. Our study suggested that dark shipping for up to 21 days is possible for nobile-type dendrobiums. We recommend shipping temperatures of 10 to 15 °C to reduce the detrimental effects caused by long-term dark shipping.

The demand for the nobile-type dendrobium as a potted orchid has been increasing worldwide. The unique flowering characteristics are one of the reasons for its increased popularity. Using sea freight to transport living plants globally is an effective way to reduce shipping costs compared with air freight. However, shipping by sea from Taiwan to the United States requires 2 to 3 weeks. During shipping, plants receive no light and no water, which leads to drought and other stresses. Thus, questions regarding whether long-term dark shipping is detrimental to the plants need to be addressed.

During long-term shipping, plants may be exposed to drought stress as a result of no watering while en route. Mittleheuser and van Steveninck (1969) reported that abscisic acid is responsible for stomatal closure during the stress response to reduce the transpiration rate. During drought stress, the progressive closure of stomata leads to a decrease in Pn (Medrano et al., 2001). Lopez and Runkle (2008) reported that, regardless of the temperature and duration of the storage, there was a decrease of Pn in Impatiens hawkeri ‘Harmony White’ cuttings compared between pre-storage and 11 d after storage. When the storage duration increased from 0 to 5 d, Pn decreased from 10.6 to 2.4 μmol·m-2·s-1 of CO2 and respiration of the cuttings increased. With Phalaenopsis Sogo Yukidian ‘V3’, Pn was significantly reduced after long-term dark shipping and 6 to 9 d were required for Pn to recover after termination of dark shipping (Hou et al., 2010).

Post-production flower longevity may also be compromised after shipping. For example, the longevity of Kalanchoe shipped for 9 d was shortened by 1 week compared with Kalanchoe shipped for 3 d (Leonard and Nell, 2000). In addition to flower longevity, shipped plants might also produce different flowering characteristics compared with non-shipped plants. Rajapakse et al. (1996) found that flowers grown from cuttings of chrysanthemum ‘Anna’ stored at 0 or 3 °C were smaller than those grown from nonstored cuttings. However, Lopez and Runkle (2008) reported no apparent effects of storage temperature or duration on the time required to flowering for New Guinea impatiens. Thaxton et al. (1988) reported that after storage at 30 °C, bud abscission of Hibiscus rosa-sinensis increased, even when they were stored for only 4 d. Hibiscus stored at 10 °C had a better visual quality compared with those stored at 20 and 30 °C. In poinsettias, rooting quality was negatively impacted after 2 d of storage at 20 and 25 °C, 4 d at 0 °C, 6 d at 5 °C, and 8 d at 10 and 15 °C compared with nonshipped plants (Faust and Enfield, 2010).

Lin et al. (2011) found that 2 weeks of 10 °C cooling is sufficient to complete vernalization on D. Sea Mary ‘Snow King’ and D. Love Memory ‘Fizz’. However, no research was found in the literature regarding the effect of long-term dark shipping on photosynthetic nobile-type dendrobiums. Therefore, this research examined the effect of shipping environment, in terms of the duration and temperature, for nobile-type dendrobiums. Furthermore, assessment of the flowering quality of nobile-type dendrobium after shipping was also investigated.

Materials and Methods

Plant materials
Vegetatively propagated, unnamed clones of two nobile-type dendrobium hybrids were used in the experiments. Dendrobium Lan Tarn Beauty plants were purchased in early Sept. 2010 from an orchid nursery in Chiayi, Taiwan, and those with two current pseudobulbs were selected. Plants were at least 30 cm tall with at least nine nodes on the main current pseudobulb and grown in 6.9-cm-diameter clear, soft plastic pots. Dendrobium Lucky Girl plants were also purchased in early Sept. 2010 from an orchid nursery in Douliu, Taiwan. These plants were at least 25 cm tall with at least 10 nodes on the main current pseudobulb and grown in 4.6-cm-diameter clear, soft plastic pots. Both cultivars were grown in sphagnum moss,
and the terminal leaf had already formed. After arrival, plants were repotted with new sphagnum moss medium without removing the old sphagnum moss. *Dendrobium* Lan Tarn Beauty was repotted into 8.9-cm-diameter pots, whereas *D. Lucky Girl* was repotted into 7.1-cm-diameter pots. Plants were then kept for approximately one month in a Venlo greenhouse and were watered as needed with tap water. No fertilizer was applied during the experimental period according to commercial practices (Yen et al., 2008a).

**Experimental locations**

Experimental facilities used in these experiments included 1) a Venlo greenhouse, equipped with a pad-and-fan cooling system and double shadecloths programmed to maintain minimum to maximum temperatures of 18 to 28 °C with a maximum photosynthetic photon flux (PPF) of 370 μmol·m⁻²·s⁻¹; 2) a phytotron, a temperature-controlled greenhouse with a glass roof to allow natural lighting, and day/night temperatures used in these experiments were 25/20 and 15/13 °C; 3) a dark storage room, a controlled-temperature chamber with no lighting, used for SDS for both experiments; and 4) a cut-flower laboratory used to simulate an environment for observing the shelf life of plants. The temperature was set to 25 °C, and the photoperiod was set from 0700 HR to 1900 HR, with experiments were 25/20 and 15/13 mol·m⁻²·s⁻¹ provided by cool-white fluorescent lamps.

**Experimental processes**

The experiment processes consisted of the following six defined stages: 1) pre-SDS was the period when plants were moved from the Venlo greenhouse and placed in a 25/20 °C phytotron; 2) SDS treatment was given by packing the plants together with shredded paper into a sealed carton box and transferring them to the dark storage room at the designated temperature and duration; 3) photosynthetic activity was measured in a 25/20 °C phytotron after SDS treatment was ended; 4) vernalization was done in a phytotron at 15/13 °C day/night temperatures after completion of photosynthetic activity observations; 5) flower bud development was allowed to occur in a phytotron of 25/20 °C (after 28 Jan. 2011, the flower bud development process was allowed to continue in a Venlo greenhouse, and plants remained in the Venlo greenhouse until 50% of the flower buds had opened); and 6) shelf life observations were done by transferring blooming plants to the cut-flower laboratory, and data were recorded until all of the flowers showed signs of senescence.

**Measurements and data collection**

Flowering parameters observed in the experiments were limited to the main current pseudobulb. The main current pseudobulb was defined as the mature pseudobulb produced in the spring of the current year, which had never flowered. For *D. Lan Tarn Beauty*, the main current pseudobulb was defined as that with the greatest number of nodes. Flower diameter was calculated as the average of diameters from three fully opened flowers: 1) the first open flower; 2) one flower from the node above the first open flower; and 3) one flower from the second node above the first open flower. Time to the first flower open was determined as the time required from the end of cooling to anthesis. Shelf life was calculated as the time from when 50% of the flower buds had opened to when 50% of the flowers showed symptoms of senescence.

Pn was measured on the third leaf from the top (L3) of the main current pseudobulb. For cases in which the third leaf was not available (e.g., the leaf had dropped), the measurement was done on the fourth, fifth, or sixth leaf from the top (L4 to L6). The measurement was done using a portable photosynthesis system (LI-6400; LI-COR, Lincoln, NE). A 6-cm² leaf chamber was used to clamp onto L3, and CO₂ was supplied using the LI-6400 internal mixer to provide 350 μmol·m⁻²·s⁻¹ CO₂. Light was provided internally by light-emitting diode lamps, and the intensity emitted was set to automatic adjustment to match the real-time natural lighting in the phytotron. Photosynthetic activity was measured from 0800 hr to 1300 hr.

Chlorophyll fluorescence was measured on the same leaf on which the Pn was measured. The leaf was first clamped with a leaf clamp for 40 min to allow dark adaptation. Then, the minimal fluorescence (Fo) was determined by maximal fluorescence (Fm) measurements. The ratio of fluorescence (Fv/Fm) was then calculated, where Fv = Fm – Fo. The chlorophyll fluorescence was measured with a photosynthesis yield analyzer (MINIPAM; Heinz Walz, Effeltrich, Germany). Chlorophyll fluorescence was measured from 0800 hr to 1030 hr.

The leaf relative water content (RWC) was measured as described by Andrade (2003), which was defined as (fresh weight – dry weight)/(turgid weight – dry weight). Leaf disks (with a diameter of 0.5 cm) were sampled from L4 and immediately weighed (fresh weight). Leaf disks were then soaked in distilled water at 4 °C for 24 h and re-weighted as the turgid weight. The dry weight was measured after dehydrating the leaf disks at 65 °C for 48 h. The RWC was measured on a leaf assigned only for the RWC measurement. Therefore, the Pn and chlorophyll fluorescence were measured on a leaf that was not used for the RWC measurement.

Leaf loss was calculated by subtracting the number of leaves remaining from the initial total leaf number at the time of measurement. The initial total leaf number refers to the number of leaves on the main current pseudobulb before SDS. Remaining leaves were leaves that were green with no yellowing and still firmly attached to the pseudobulb.

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**Fig. 1.** Changes in the net CO₂ uptake rate (A), chlorophyll fluorescence (Fv/Fm) (B), and leaf relative water content (C) of *Dendrobium* Lan Tarn Beauty plants before and after simulated dark shipping (SDS). SDS was conducted by treating plants with dark storage for 7, 14, or 21 d at 15 °C. Control plants were maintained in a phytotron with 25/20 °C day/night temperatures. Upward arrows indicate watering. Bars represent LSD₀.₀₅; n = 10. LSD = least significant difference.
Expt. 2: Effects of temperature during simulated dark shipping on the post-shipping photosynthetic status and subsequent flowering. The objective of this experiment was to determine the optimal temperatures for long-term dark shipping of nobile-type dendrobium. The assessment was done by comparing the post-shipping photosynthetic status and subsequent flowering quality of nobile-type dendrobium. Fifty plants of each cultivar were transferred on 18 Oct. 2010 to a phytotron set for 25/20 °C day/night temperatures. Twenty plants were randomly selected from each cultivar for pre-SDS measurements. Plants from each cultivar were then divided into five groups of 10 plants each for shipping temperature treatments. On 1 Nov. 2010, treated groups were packed and began SDS for 21 d at 10, 15, 20, or 25 °C. Control plants were maintained in a 25/20 °C phytotron. The Pn, leaf chlorophyll fluorescence, leaf RWC, and leaf retention were measured on Days 0, 1, 2, 4, 6, 8, and 11 after the completion of SDS. All plants were then vernalized in a 15/13 °C phytotron for 33 d from 3 Dec. 2010 to 5 Jan. 2011. Other processes were the same as those in Expt. 1.

Statistical analysis

All data were subjected to an analysis of variance using a completely randomized design. Separation of means among treatments was obtained using the least significance difference test at \( P \leq 0.05 \). Statistical analyses were done using Costat 6.1 (CoHort Software, Monterey, CA). All figures were extrapolated from the data using SigmaPlot 10.0 (Systat Software, Inc., San Jose, CA).

Results

Both *D. Lan Tarn Beauty* and *D. Lucky Girl* showed similar results for the photosynthetic status. Therefore, only the results of *Lan Tarn Beauty* are presented in this article. Results of flowering quality for both cultivars are presented.

Expt. 1: Effects of the duration of simulated dark shipping on post-shipping photosynthetic status and subsequent flowering. On the last day (Day 0) of SDS treatment, no yellow leaves were found on either cultivar, but several dried and abscised leaves were found inside the packaging container (data not shown). On Day 1, Pn values were similar between plants that received 7 d of SDS and the controls. However, Pn values of plants treated with 14 or 21 d of SDS were both \( \approx 0 \mu \text{mol·m}^{-2} \cdot \text{s}^{-1} \) CO₂ on the same day (Fig. 1A). Net CO₂ uptake rates of plants treated with 14 or 21 d of SDS recovered to levels of control plants by Days 6 and 12, respectively.

Results of chlorophyll fluorescence showed that, on Day 0, only plants treated with 7 d of SDS had similar values to control plants, whereas the other treatments had lower values. Plants shipped with longer durations had slower recovery in their Fv/Fm values. However, throughout the observation, values of Fv/Fm ranged from 0.77 to 0.83 (Fig. 1B). These values indicate no significant damage to photosystem II (PSII) and suggest that the decrease in Pn was not likely caused by PSII damage. There was no discernible fluctuating pattern in leaf RWC (Fig. 1C). On Day 0, the RWC ranged from 92.6% to 95.6% among all treatments. This indicated that the water content in the leaf was unaffected by SDS. *Dendrobium* Lan Tarn Beauty plants treated with 21 d of SDS were the first to flower among all treatments. Calculated from the end of vernalization, the plants required only 39 d to flower, whereas control plants required 44 d (Table 1). Results indicated that cold temperature experienced during SDS shortened the duration needed for vernalization. The number of nodes with flowers, total flower count, flower bud abortion, and inflorescence abortion were similar between the shipped and control plants. However, the flowers were smaller in *D. Lan Tarn Beauty* treated for 7 or 14 d compared with control plants (Table 1). No difference was found in shelf life between shipped and control plants of *D. Lan Tarn Beauty*. These results indicate that a shipping duration of up to 21 d promoted early flowering but produced no significant reduction in flowering quality in *D. Lan Tarn Beauty*. However, increasing the duration of shipping from 7 to 21 d resulted in an increase in the leaf loss percentage from 0% to 3%. Unlike *D. Lan Tarn Beauty*, a prolonged shipping duration of 14 and 21 d shortened the shelf life of *D. Lucky Girl* by 3 to 4 d (Table 1). Regardless of the duration, control plants had bigger flowers but shipped plants produced more flowers (Table 1).

Expt. 2: Effects of temperature during simulated dark shipping on the post-shipping photosynthetic status and subsequent flowering. After completing SDS, several shipped

Table 1. Effects of the simulated dark shipping (SDS) duration on the time to the first flower open, the number of nodes with flowers, total flower count, flower diameter, flower bud abortion, inflorescence abortion, shelf life, and leaf loss percentage of dendrobium.

| Storage duration (d) | Time to first flower open (d) | Nodes with flowers (no.) | Total flower count (no.) | Flower diam (cm) | Flower bud abortion (no.) | Inflorescence abortion (no.) | Shelf life (d) | Leaf loss (%) |
|----------------------|-------------------------------|--------------------------|--------------------------|------------------|---------------------------|-----------------------------|----------------|---------------|
| **D. Lan Tarn Beauty** |                               |                          |                          |                  |                           |                             |                |               |
| 0 (control)          | 44 a 1                        | 6.9 a                    | 16.5 a                   | 5.0 a            | 0.6 a                     | 2.2 a                        | 27 a            | 0 b           |
| 7                    | 42 ab                         | 8.4 a                    | 19.9 a                   | 4.7 b            | 0.8 a                     | 1.9 a                        | 25 a            | 0 b           |
| 14                   | 41 bc                         | 7.3 a                    | 17.2 a                   | 4.6 b            | 0.5 a                     | 2.0 a                        | 26 a            | 1 ab          |
| 21                   | 39 c                          | 7.4 a                    | 17.0 a                   | 4.8 ab           | 0.4 a                     | 0.7 a                        | 23 a            | 3 a           |
| **D. Lucky Girl**    |                               |                          |                          |                  |                           |                             |                |               |
| 0 (control)          | 44 ab                         | 4.7 b                    | 10.5 b                   | 4.5 a            | 0 b                       | 0.7 a                        | 38 a            | 1 ab          |
| 7                    | 45 a                          | 6.7 a                    | 16.2 a                   | 4.3 b            | 0 b                       | 0.9 a                        | 38 a            | 0 b           |
| 14                   | 43 b                          | 6.3 a                    | 16.6 a                   | 4.2 b            | 0 b                       | 0.6 a                        | 35 b            | 0 b           |
| 21                   | 43 b                          | 5.9 ab                   | 17.4 a                   | 4.2 b            | 0.2 a                     | 0.7 a                        | 34 b            | 5 a           |

aSDS was conducted by storing plants in a dark cold-storage room at 15 °C for the designated duration. Control plants did not receive SDS treatment and were maintained in a phytotron at day/night temperatures of 25/20 °C.

bNumber of dropped leaves counted on Day 4 after termination of SDS divided by the total leaf no. before SDS treatment.

cMeans followed by a different letter in columns and for different cultivars are significantly different at \( P \leq 0.05 \) by the least significant difference test; \( n = 10 \).
D. Lan Tarn Beauty plants produced new etiolated shoots that gradually turned green after being placed in the 25/20 °C phytotron (data not shown). Pseudobulbs of D. Lucky Girl receiving 20 or 25 °C were wrinkled and thinner compared with those in other treatments (data not shown). After plants were watered at the end of Day 1, the pseudobulbs became plump by Day 2 (data not shown).

For both cultivars, Pn of all shipped plants were nearly 0 μmol·m⁻²·s⁻¹ on Day 0 (Fig. 2A for D. Lan Tarn Beauty; data not shown for D. Lucky Girl). Dendrobium Lan Tarn Beauty treated with 10 or 15 °C SDS showed no difference in Pn values compared with the controls after 4 d. Plants treated with 20 and 25 °C SDS required 8 to 11 d to reach similar Pn values as the controls (Fig. 2A).

All shipped plants had lower Fv/Fm values on Days 0 and 1 than the controls (Fig. 2B). The Fv/Fm for D. Lan Tarn Beauty shipped at 10 or 15 °C recovered by Day 2 and those shipped at 20 or 25 °C recovered by Day 6. The Fv/Fm values of shipped plants ranged between 0.76 and 0.80 during the recovery period, indicating that damage to PSII was insignificant. The leaf RWC measured after SDS treatment showed a minimum value of 87.7% (Fig. 2C, Day 2). During the observation, RWC values of all plants fluctuated with no recognizable pattern. This, combined with the incidence of shrunken pseudobulbs, suggests that water was lost mainly from the pseudobulb during the simulated shipping.

Lateral buds of Dendrobium Lan Tarn Beauty plants treated with 10 °C SDS sprouted within 6 d after SDS (data not shown). This was not found on plants from other treatments or with the other cultivar. These lateral buds were then developed into inflorescences. The overall appearances of flowering plants did not differ between shipped and control plants (Fig. 3).

Dendrobium Lan Tarn Beauty plants shipped at 10 and 15 °C flowered 5 and 3 d, respectively, earlier than control plants (Table 2). Those treated at 20 or 25 °C flowered at the same time as control plants. The number of nodes with flowers, the total flower count, flower bud abortion, and inflorescence abortion did not differ among treatments (Table 2). Treatment did not affect shelf life of D. Lan Tarn Beauty (Table 2) and except for SDS 10 °C, all other temperatures resulted in more leaf loss than the control (Table 2). These results indicate that shipping temperature of 10 and 15 °C produced a vernalization effect on D. Lan Tarn Beauty. Shipping at 10 °C also resulted in an increased flower diameter, and plants were able to retain more leaves.

Fig. 3. Flowering performance of Dendrobium Lan Tarn Beauty (A) and D. Lucky Girl (B) plants treated with simulated dark shipping for 21 d under a temperature of 10, 15, 20, or 25 °C. Control plants were maintained in a phytotron at 25/20 °C day/night temperatures without shipping simulation. Plants were vernalized for 33 d at 15/13 °C. The photo was taken 61 d after vernalization.
Dendrobium

Lucky Girl plants treated with 10 °C SDS were also the first to flower among all treatments, 8 d earlier than control plants (Table 2). Different from D. Lan Tarn Beauty, all shipped D. Lucky Girl plants had a higher number of nodes with flowers and total flower count (Table 2). The flower diameter and number of aborted inflorescences of control plants were higher than those of all shipped plants (Table 2). However, unlike D. Lan Tarn Beauty, the shelf life of shipped D. Lucky Girl plants did not significantly differ from the controls, except with 20 °C treatment (Table 2). These results indicated that D. Lucky Girl was more tolerant of shipping temperatures and gained some vernalization effects during shipping regardless of the shipping temperatures between 10 and 25 °C. The highest leaf loss was found in plants treated at 20 and 25 °C SDS (Table 2).

### Discussion

All shipped plants, under various durations and temperatures, had Pn values of ≈0 μmol·m⁻²·s⁻¹, except plants treated with 7 d of SDS (Figs. 1A and 2A). During shipping, plants were exposed to stresses such as darkness and dehydration. Stomatal closure is a common response to dehydration (Davies et al., 1981) to reduce water loss (Mittelheuser and van Steveninck, 1969). Therefore, limitation of Pn in shipped dendrobiums after SDS was likely caused by low stomatal conductance (data not shown) as a result of stomatal closure. In D. Lan Tarn Beauty, Pn values were similar between control plants and plants treated with 7 d of SDS (Fig. 1A). The negative effect of long shipping durations on Pn was amplified when the duration of shipping was longer than 7 d. Considering the time required to recover the photosynthetic activity, 10 and 15 °C are optimal for shipping these two nobile-type dendrobium cultivars.

Although longer shipping duration and higher shipping temperature caused slower recovery in Fv/Fm values, those values were still within the range of non-stressed plants (0.75 to 0.85) in both experiments (Figs. 1B and 2B) as described by Bolhar-Nordenkampf et al. (1989). In addition, plants were able to recover their ability to conduct photosynthesis to the level before SDS treatment. These suggest that the reduction in Pn was not likely caused by damage to the photosystem. However, as the degree of stress increased (a longer shipping duration or a higher shipping temperature), the time needed to recover their Pn also increased (Figs. 1A and 2A).

Pseudobulbs act as a storage organ in orchids (Hew and Yong, 2004). The unaltered leaf water content and the shrunken pseudobulbs of D. Lucky Girl after SDS treatment at 20 and 25 °C indicate that water was lost from pseudobulbs during the storage period (data not shown). It would be interesting in future research to determine whether water and photosynthate for respiration were provided and regulated by the pseudobulb during the entire shipping period.

Previous research showed that storage of Phalaenopsis Atien Kaala ‘TSC 22’ darkness for 14 d or less at 15 or 25 °C did not affect the time required for spiking (Wang, 2007). In Phalaenopsis Sogo Yukidian ‘V3’, a longer duration (14 to 21 d) at 20 °C of shipping delayed spiking (Hou et al., 2010). Nobile-type dendrobium requires vernalization to induce successful spiking under low temperatures (Wang, 1995). No spiking was found for Phalaenopsis Joseph Hampton when stored for 6 weeks at 20/15 °C day/night temperatures when the light intensity was 0 or 8 μmol·m⁻²·s⁻¹ PPF, despite the temperature being sufficient to induce spiking (Wang, 1995). In nobile-type dendrobium, however, successful flower induction was achieved even when plants were vernalized in darkness; D. Love Memory ‘Fizz’ and D. Sea Mary ‘Snow King’ were vernalized by 2 weeks of 10 °C, whether in the dark or light (Lin et al., 2011).

In conclusion, nobile-type dendrobiums can experience long-term dark shipping for up to 21 d at 15 °C with only minor negative effects of SDS on the subsequent flowering performance. The photosynthetic activity of nobile-type dendrobiums was unaffected when shipped for 7 d at 15 °C. With long-term dark shipping, we suggest using temperatures of 10 to 15 °C to reduce detrimental effects on post-shipping photosynthesis and flowering performance. Low temperatures experienced during dark shipping partially fulfilled the needs of vernalization in nobile-type dendrobiums such that shipping at 10 or 15 °C for 21 d resulted in early flowering. In cases in which the shipping temperature is elevated, as a result of machinery malfunction or other causes, nobile-type dendrobiums can still endure high temperatures of up to 25 °C with only a slight decrease in the shelf life of flowering plants.

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