Postharvest Characteristics of cut Inflorescences of *Lupinus havardii*

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Summary. Big Bend bluebonnet *(Lupinus havardii* Wats.) is native to a narrow geographic range in southwestern Texas and produces attractive blue inflorescences (racemes) that may be used as cut flowers. Several crops were produced in the greenhouse to determine postharvest-characteristics of the cut inflorescences. Without any postharvest conditioning treatments, the inflorescences held in water had an average vase life of about 7 days. During this period, an average of 13 flowers abscised per inflorescence. When preconditioned for 4 hours in 40 to 160 mg·liter^{-1} silver thiosulfate (STS), vase life increased to 10 to 12 days and fewer than three flowers abscised per inflorescence. A commercial floral preservative (Oasis) had no effect on flower abscission or vase life of STS-treated inflorescences. Flower abscission and vase life were the same whether STS-treated inflorescences were placed in floral foam moistened with water or in water alone. Storing STS-preconditioned inflorescences in water at 5C for 72 hours did not affect flower abscission or vase life compared to the unstored control. Dry postharvest storage at 5C for 72 hours caused noticeable wilting, but, on dehydration, these inflorescences still had a vase life of about 8 days. Postharvest characteristics of pink- and white-flowered breeding lines were the same as for the blue-flowered line. These results indicate that cut inflorescences of *L. havardii* have desirable postharvest qualities and can be stored for up to 72 hours without seriously limiting vase life.

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Lupinus havardii, commonly known as Big Bend or Chisos bluebonnet, is. a showy winter annual that can reach 1.0 to 1.5 m in height and produces blue, fragrant inflorescences (racemes). Not to be confused with the much shorter (0.3 to 0.5-m tall) and more widely distributed *L. texensis* (Texas bluebonnet), ***L. havardii*** is native to a narrow geographic range along the Mexican border in southwestern Texas (Andrews, 1986). The inflorescence of *L. havardii* has considerable potential in the cut-flower industry where there is a need for high-quality, durable flowers with a strong vertical accent (Davis et al., 1994). Also, blue flowers are rare and *L. havardii* could help fill this important color niche in the floral market.

Preliminary trials indicated that *L. havardii* is quite adaptable to greenhouse culture (Davis et al., 1994). The plants grow rapidly and begin producing flowers 2 to 3 months after the seed is planted, without any special environmental treatments such as chilling or photoperiod manipulation. However, nothing is known about the postharvest characteristics of the cut in florescence. Accordingly, we conducted experiments to gain such information. Specifically, we evaluated the effects of several postharvest treatments on flower abscission and vase life.

Materials and methods

Inflorescences of *L. havardii were* produced in a nonshaded glasshouse from November 1993 to May 1994. Plants were grown from scarified seed in cell packs (48 cells/flat) and transplanted to 12-liter plastic pots (25 cm in diameter; 25 cm high) after 1 month. The growing medium was Metro Mix 200 (Grace Sierra, Milpitas, Calif.), and each plant was fertilized with Sierra 17N–6P–12K Plus minors (Grace Sierra) at 36 g/pot (6.1 g N/pot). Inflorescences began reaching harvest

stage about 2.5 months after sowing, and harvesting continued for 2 to 2.5 months thereafter. Inflorescences were harvested in the morning (generally from 0900 to 1100 HR) when they reached 40 to 50 cm in length and had 30 to 40 open flowers. Staggered plantings were used so that a constant supply of flowers was available during the experimental period. No differences in flower quality, vase life, or abscission were observed during this time. Greenhouse temperature during production was 25 to 30C during the day and 13 to 18C at night. Four separate experiments were conducted with the harvested inflorescences.

Silver thiosulfate(STS) experiment. Immediately after harvest, inflorescences were placed in an aqueous solution of 0, 40, 80, or 160 mg·liter^{-1} STS for 4 h. During this period, the inflorescences were kept in a growth chamber at 24C and 20 ± 5 µmol·m^{-2}·s^{-1} photosynthetic photon flux (PPF). After STS treatment, inflorescences were placed in vases containing water.

Floral foam-preservative experiment. Immediately after harvest, inflorescences were placed in an aqueous solution of 80 mg·liter^{-1} STS for 4 h under the same conditions as for the STS experiment described above. After STS treatment, the inflorescences were a) transferred to vases containing water or 9 g·liter^{-1} Oasis floral preservative (Smithers-Oasis, Kent, Ohio) or b) inserted into Oasis floral foam moistened with water or 9 g·liter^{-1} Oasis floral preservative. The floral preservative dose followed label recommendations. Preliminary trials indicated that the floral preservative had little effect on postharvest performance of inflorescences not treated with STS. Therefore, only STS-treated inflorescences were used for this experiment.

Storage experiment. Immediately after harvest, inflorescences were placed in an aqueous solution of 80 mg·liter^{-1} STS for 4 h under the conditions described in the STS experiment. After STS treatment, the inflorescences were a) placed in vases containing water (nonstored control); b) placed in vases containing water and stored in a dark cold room at 5C for 72 h (wet storage); or c) placed horizontally in a cardboard box, covered with paper towels lightly sprinkled with water, and stored in a dark cold room at 5C for 72 h (dry storage). After storage, the inflorescences were recut and placed in vases containing water.

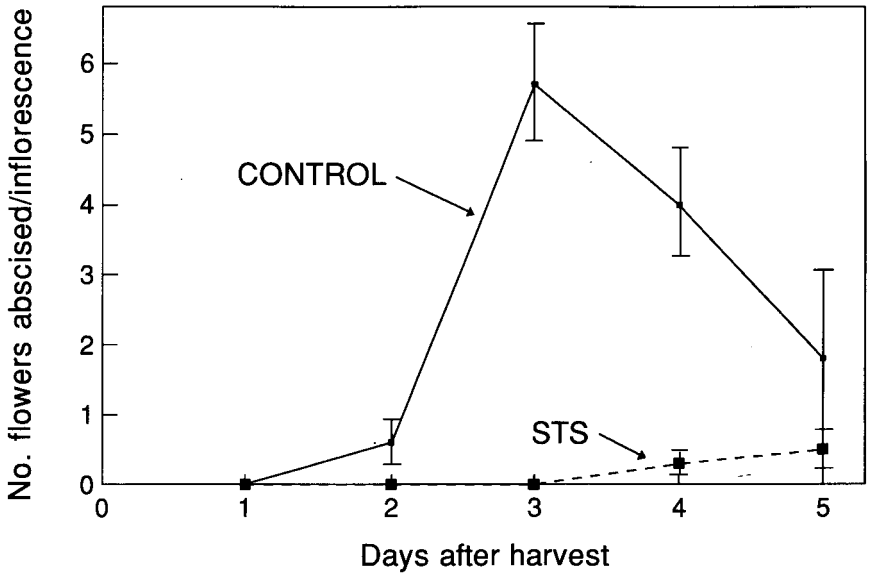

Fig. 1. *Daily flower abscission from cut inflorescences of* Lupinus havardii as *influenced by a 4-h 80-mg·liter silver thiosulfate (STS) treatment immediately after harvest. Vertical bars indicate standard error of the mean.*

Color line comparison. Inflorescences were harvested from blue-, pink-, and white-flowered breeding lines under development at Texas A&M Univ. Immediately after harvest, inflorescences were placed in an aqueous solution of 80 mg·liter^{-1} STS for 4 h under the conditions described in the STS experiment. Thereafter, inflorescences were kept in vases filled with water.

After treatment, all inflorescences were held in a growth chamber at 24C with a 16-h photoperiod and a PPF of 20 ± 5 µmol·m^{-2}·s^{-1} provided by cool-white fluorescent lamps. The number of flowers abscised was counted daily for each treatment. Vase life was considered complete when < 8 cm of the in florescence contained fresh flowers (about 10 to 12 fresh flowers remaining). All experiments were conducted at least three times with at least seven inflorescences per treatment.

Results and discussion

Flower abscission began 2 days after harvest from the inflorescences not treated with STS (Fig. 1). Flower abscission from these inflorescences was quite high within 3 to 4 days after harvest. Thereafter, flower abscission subsided, but the lower-most remaining flowers on the in florescence began to dry and shrivel. Also, 5 to 10 new flowers opened per in florescence during the first week after harvest. After 7 days, only about 8 cm of the inflorescence contained fresh flowers (Table 1). With all of the STS-treated inflorescences, flower abscission was delayed and was much less than in the control (Fig. 1, Table 1). Over the first week after harvest, 13 flowers abscised per inflorescence in the controls, whereas < 3 flowers abscised per STS - treated inflorescence (Table 1). Vase life was extended 3 to 5 days by the STS preconditioning treatments. Thus, as with some other cut-flower crops (Reid et al., 1980; Staby et al., 1993), a STS preconditioning treatment immediately after harvest was effective in extending the vase life of cut inflorescences of *L. havardii.* However, using STS may be restricted in the future because of environmental concerns (Nell, 1992). Thus, other conditioning alternatives should also be evaluated for *L. havardii.* Because STS acts by inhibiting ethylene action (Halevy and Mayak, 1981; Veen, 1979), our current results suggest that *L. havardii* flowers are sensitive to ethylene.

After preconditioning with 80 mg·liter^{-1} STS, *L. havardii* inflorescences had a vase life of about 10 days when placed in either water or floral foam moistened with water (data not shown). Also, flower abscission was low (less than three flowers abscised per inflorescence), regardless of whether the inflorescences were kept in water or floral foam. Thus, water and floral foam are suitable media for displaying cut in florescences of *L. havardii.* Adding the floral preservative to either of these media had no influence on flower abscission or vase

Table 1. *Effect of a 4-h postharvest silver* thiosulfate (STS) treatment on flower *abscission and vase life of cut inflorescences of* Lupinus havardii.

Postharvest characteristic	STS treatment (mg·liter^{-1})				
	0 (control)	40	80	160	Significance
Number of flowers abscised/inflorescence[z]	13.4	1.0	2.6	1.4	Q[y]
Vase life[x] (days)	7	12	11	10	Q

[z]*During first 7 days following harvest*
[y]*Treatment effects were quadratic (Q) at P = 0.05 as determined by polynomial regression analysis (n > 22).*
[x]*Vase life considered complete when < 8 cm of the inflorescence containedfresh flowers (10 to 12 flowers remaining.).*

Table 2. *Effect of 72 h storage at* 5C *on flower abscission and vase life of STS-treated (80 mg·liter^{-1}) cut inflorescences of* Lupinus havardii.

Postharvest characteristic	Storage treatment		
	Control	Stored in water	Stored dry
Number of flowers abscised/inflorescence[z]	1.0 a[y]	1.0 a	1.5 a
Vase life[x] (days)	10 a	9 ab	8 b

[z]*During first 7 days following harvest (control) or storage.*
[y]*Means in vows with a common lower case letter are not significantly different at P =0.05 as determined by Scheffe test (n= 41).*
[x]*Vase life considered complete when < 8 cm of the inflorescence contained fresh flowers (10 to 12 flowers remaining).*

life (data not shown).

Cut inflorescences stored at 5C in water for 72 h in the dark appeared in good condition at the end of the storage period and were visually indistinguishable from freshly cut inflorescences. No flower abscission occurred during storage. The inflorescences stored dry at 5C were noticeably wilted after 72 h. By that time, the paper towels covering the inflorescences had become dry. However, after being recut and placed in water, the inflorescences regained turgidity within about 90 min. This ability to rehydrate was quite impressive and may be related to the fact that this species is native to an arid region. Flower abscission and vase life were unaffected by storage in water at 5C for 72 h (Table 2). Dry storage at 5C for 72 h reduced vase life by about 2 days but did not affect flower abscission. The results of our storage experiment indicate that cut in florescences of *L. havardii* are amenable to storage for up to 72 h without practical reductions in postharvest quality and vase life.

Vase life was the same (about 10 days) for the blue-, pink-, and white-flowered breeding lines (data not shown). Thus, up to this point, recurrent phenotypic selection for novel flower color has not inadvertently altered postharvest characteristics of the inflorescences.

Taken together, our results suggest that cut inflorescences of *L. havardii* have several desirable postharvest qualities (e.g., reasonable vase life when treated with STS, ability to be stored, and good performance in water or floral foam). A major factor that will determine the long-term suitability of this plant as a cut-flower crop will be whether postharvest flower abscission can be controlled adequately. Although STS is quite effective in this regard, the development of other more environmentally sound conditioning treatments would be desirable. Also, breeding efforts are underway to reduce sensitivity to ethylene, thereby genetically regulating flower abscission (Davis et al., 1994). Another important factor in determining the long-term suitability of *L. havardii* as a cut-flower crop will be whether the inflorescences can withstand the rigors of long-range shipping.

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