

**ABA Drenches Induce Stomatal Closure and Prolong Shelf  
Life of *Salvia splendens***

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**Index Words:** retail, postproduction, drought, bedding plant, stomatal conductance, transpiration

**Significance to Industry:** Providing adequate water to bedding plants during retail is often problematic, and drought stress can shorten their shelf life. To help plants conserve water and reduce water needs, stomatal closure can be induced by applying abscisic acid (ABA). ABA drenches caused stomatal closure in salvia (*Salvia splendens* Sellow ex Schult.) 'Bonfire' within three hours of application. ABA-induced stomatal closure and reduced transpiration caused a much slower decrease in the water content of the substrate ( $\theta$ ). This water conservation delayed wilting by two (250 - 500 ppm) to three days (1000 - 2000 ppm). A negative side effect of ABA was a rate-dependent leaf abscission. ABA applications can be used to extend the shelf life of salvia, but the lowest possible dose should be used to minimize leaf abscission.

**Nature of Work:** The shelf life of ornamental plants in retail stores depends on their aesthetic condition and how quickly it deteriorates. Inadequate watering is a common cause of decreases in aesthetic quality, and can lead to severe drought stress, wilting, and plant death. The plant hormone ABA induces stomatal closure and has been shown to reduce water loss from bedding plants for 2 days after application, while synthetic ABA analogs have a longer-lasting effect (3). ABA has potential to improve the shelf life of greenhouse crops (1); shelf life of a variety of bedding plants was increased by 1 to 6 days after drenches with 125 or 250 ppm ABA (2). Our objective was to quantify how ABA affects water uptake from the substrate, as well as the physiology and quality of the plants. We used salvia as a model crop because it is very drought-sensitive.

Salvia 'Bonfire' seeds were sown in 72-cell plug trays and transplanted into 4" square plastic pots with soilless medium (60% peat – 40% perlite, Fafard 2P, Conrad Fafard, MA) after one month. Plants were grown in a glass-covered greenhouse and when they became marketable, plants were drenched with 50 mL of 0, 250, 500, 1000, or 2000 ppm ABA. All ABA solutions were prepared by diluting a 10% (w/v) stock solution (VBC-30074, Valent BioSciences Co., Libertyville, IL) with deionized water. Plants were no longer watered after the ABA application.

During the following 10 days, volumetric substrate moisture content ( $\theta$ ) was measured every 10 minutes with soil moisture sensors (EC-5, Decagon Devices, Pullman, WA). Stomatal conductance ( $g_s$ ) was measured four times a day during the first three days after the ABA applications, and once a day thereafter (LI-1600, LI-COR, Lincoln, NE). Wilting and the number of abscised leaves from each plant were monitored throughout the experiment.

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The experimental design was a randomized complete block design with 5 blocks per treatment. Data were analyzed using linear and quadratic regression analysis (proc GLM, SAS v. 8.1, SAS Institute, Cary, NC). Because hormonal effects are commonly not directly proportional to the applied dose, ABA concentrations ([ABA]) were transformed using  $\log([ABA] + 50)$  for the analyses of  $g_s$  and  $\theta$  data.

**Results and Discussion:** ABA applications reduced  $g_s$  within 3 hours. Control plants maintained a high  $g_s$  (Fig. 1) and transpiration rate (results not shown) throughout the first day, and had a higher  $g_s$  than ABA treated plants on the morning of the second day as well (Fig. 1). However, from 30 to 48 hours after treatment,  $g_s$  in the control treatment was lower than that in any of the ABA treatments, and  $g_s$  was highest with 250 ppm ABA. By this time, the substrate in the control treatment had dried out ( $\theta < 0.20 \text{ m}^3 \cdot \text{m}^{-3}$ ) causing drought stress and the initiation of wilting, explaining the low  $g_s$ . There were no treatment effects on  $g_s$  from 51 to 96 hours after treatment. During the latter part of the experiment (147 to 195 hours after treatment),  $g_s$  increased with increasing [ABA], because there was more water left in the substrates drenched with high [ABA], allowing those plants to continue to transpire. At the end of the experiment (219 hours after treatment), all plants were completely wilted and  $g_s$  was low and similar in all treatments.

The ABA effects on  $g_s$  and transpiration had a direct effect on  $\theta$ . Higher [ABA] resulted in higher  $\theta$  from 6 hours after treatment until the end of the experiment. During the first day after the ABA application,  $\theta$  in the control treatment decreased by  $0.48 \text{ m}^3 \cdot \text{m}^{-3}$ , from  $0.73$  to  $0.25 \text{ m}^3 \cdot \text{m}^{-3}$ . In treatments that received ABA, this decrease in  $\theta$  ranged from  $0.27$  to  $0.13 \text{ m}^3 \cdot \text{m}^{-3}$ , with smaller changes at higher [ABA]. On day 3,  $\theta$  in the control treatment was less than  $0.10 \text{ m}^3 \cdot \text{m}^{-3}$ , whereas the 250, 500, 1000, and 2000 ppm ABA treatments still had  $\theta$  of  $0.24$ ,  $0.31$ ,  $0.44$ , and  $0.47 \text{ m}^3 \cdot \text{m}^{-3}$ , respectively. The  $\theta$  in the 2000 ppm treatment did not drop below  $0.10 \text{ m}^3 \cdot \text{m}^{-3}$  until day 9.

Leaf abscission was a negative side effect of the ABA treatments, with a strong correlation between the number of abscised leaves and [ABA], starting on day 2 ( $P < 0.0001$ , Fig. 3). The number of abscised leaves increased until day 5 with little leaf abscission thereafter. Control plants started wilting on day 2, 250 and 500 ppm ABA resulted in wilting on day 4, while 1000 and 2000 ppm ABA delayed wilting until day 5. Therefore, all [ABA] extended the shelf life of salvia, but with the negative side effect of leaf abscission. ABA applications also have been shown to postpone wilting and improve the shelf life of many other bedding plant species (1, 2, 3). Further study is needed to find out the most effective concentration to increase the shelf life of bedding plants in retail settings with minimal side effects.

#### Literature Cited:

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Figure 1. Stomatal conductance of *Salvia splendens* during a 10-day period, as affected by drenches with different concentrations of ABA. 'L' and 'Q' indicate significant linear or quadratic effects of  $\log([ABA] + 50)$  on stomatal conductance at  $P = 0.05$  (\*), 0.01 (\*\*), and 0.001 (\*\*\*) and NS = non-significant. Data points represent the mean  $\pm$  standard error.

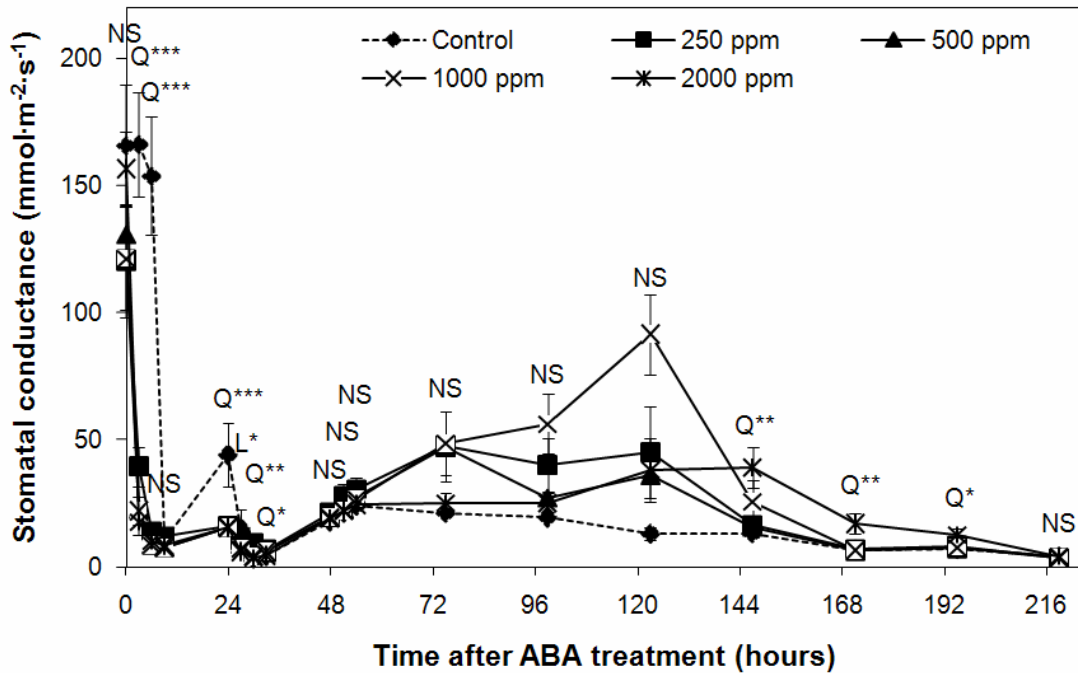


Figure 2. The substrate water content after drenches with different concentrations of ABA. 'L' and 'Q' indicate significant linear or quadratic effects of (log([ABA] + 50) at  $P = 0.05$  (\*),  $0.01$  (\*\*), and  $0.001$  (\*\*\*) and NS = non-significant. Data points represent the mean  $\pm$  standard error.

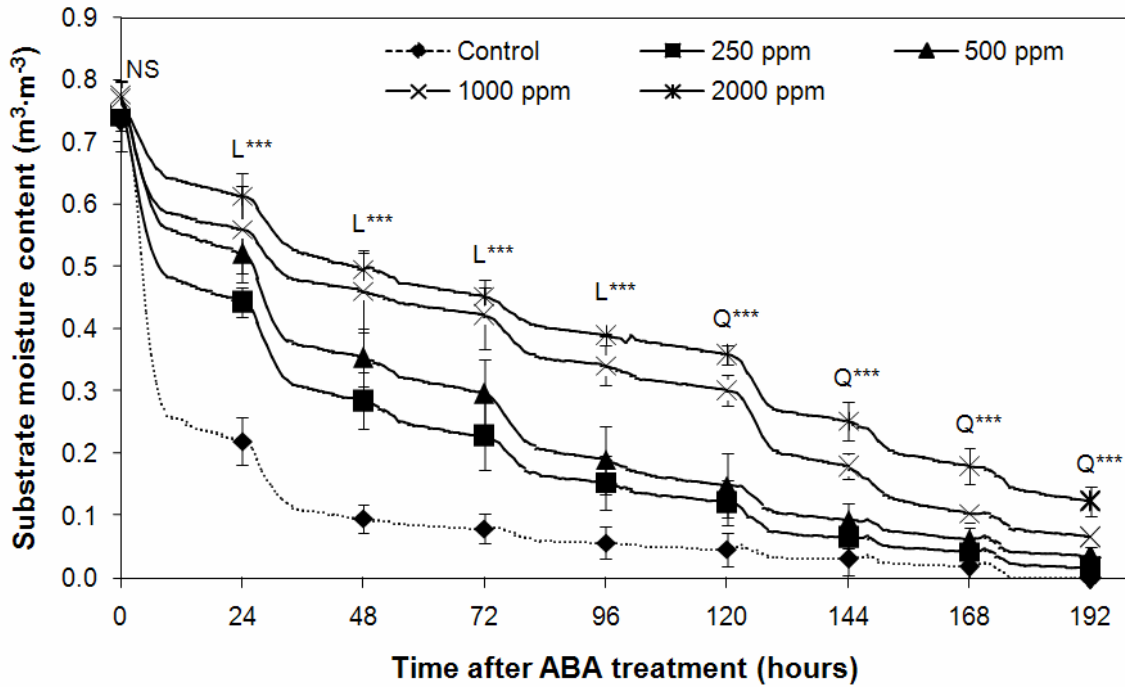


Figure 3. The effect of drenches with different concentrations of ABA on the number of abscised leaves of *Salvia splendens* 'Bonfire'. Data points represent the mean  $\pm$  standard error. There was a highly significant correlation between the ABA concentration and the number of abscised leaves throughout the study ( $P < 0.001$ ).

