Potassium Nutrition and Moisture Stress Tolerance of *Salvia*

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Elevated K fertilization during bedding plant production may reduce irrigation demand and moisture stress during marketing and landscape establishment. Lindhauer (1985) indicated increasing K fertilizer concentration reduced transpirational water loss and decreased the influence of moisture stress on gas exchange for sunflower. The objective of this study was to determine the influence of K nutrition level on gas exchange of *Salvia splendens* F. Sellow 'Bonfire' during the onset of moisture stress.

Seed of *Salvia* were sown on 11 Jan. 1988 and transplanted 14 days later into 500-ml plastic pots containing a 1 peat : 1 perlite (v/v) medium amended with 1 kg of Micromax (Sierra Chemical Co., Milpitas, Calif.) and 3 kg dolomitic limestone/m³. Plants were grown in a glasshouse under long-day conditions [night interruption from 2200 to 0200 HR using incandescent lights providing $\approx 4 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ photosynthetic photon flux (PPF) at the top of the plant canopies] to extend vegetative growth. Potassium was applied with each watering at 75, 300, or 600 mg K/liter from KCl. Each K solution also contained (in mg·liter⁻¹) 200 N from NH₄NO₃ and 25 P from phosphoric acid. Solutions were applied at the rate of 250 ml at each watering to maintain constant root-zone concentrations of nutrients. Treatments were arranged in a randomized complete block design with eight single-plant (eight pots) replicates for each treatment.

Plants were irrigated at 0545 HR and placed under supplemental lighting provided with 1000-W high-pressure sodium lamps. Levels of PPF ranged from 605 to 745 $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ during gas exchange measurements. Net photosynthesis (Pn), transpiration (E), leaf conductance (g_L), and internal CO₂ concentration (CI) were obtained using the LI-COR Model 6200 portable photosynthesis system (LI-COR, Lincoln, Neb.). Mean gas analyzer leaf chamber relative humidity, temperature, and CO₂ concentration during measurements were $38\% \pm 7\%$, $27 \pm 2^\circ\text{C}$, and $360 \pm 27 \text{ mg}\cdot\text{liter}^{-1}$, respectively. Mes-

ophyll resistance to CO₂ (r_m) was determined using the equation: $r_m = \text{CI}/\text{Pn}$ (Osonubi and Davies, 1980). Gas exchange measurements were made every 1.5 h on the same recently matured leaf of each plant from 0900 to 1630 HR on 17 Mar. and from 0900 to 1200 HR on 18 Mar. 1988 (days 65 and 66 following seeding, respectively).

Three plants per treatment were randomly selected at 0630, 1100, and 1630 HR on day I and 0630 and 1100 HR on day II to determine leaf water potential (ψ_L) with a pressure chamber (Scholander et al., 1965). Plants were harvested following the final physiological observations at 1200 HR on day II to determine shoot dry weight and total leaf area. Data analyses for variance and mean comparisons were made using Tukey's studentized range test at $P = 0.05$.

Greatest E and g_L (Fig. 1) were observed from 1330 to 1630 HR on day I for plants grown with 75 mg K/liter. There were no differences in E and g_L during day I among plants grown at 300 or 600 mg K/liter. Similar reductions in g_L and E during day I indicate the reductions in water loss with increasing K fertilizer concentrations were due to stomatal changes. Both E and g_L were lower on day II than on day I, regardless of K fertilizer concentration, and declined over time. Plants fertilized with 600 mg K/liter maintained higher E and g_L than plants fertilized with 75 mg·liter⁻¹ at the two observations on day II after 0900 HR.

Pn throughout day I was higher for plants fertilized with 75 mg K/liter than for the other treatments, peaking at $20.9 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ at 1330 HR (Fig. 1). In contrast, plants receiving 300 and 600 mg K/liter reached a peak of only $13.9 \mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ at 1200 HR. On day II, Pn continued to decline regardless of K fertilizer concentration. Final Pn observations taken at 1200 HR showed a greater Pn for plants fertilized with 600 mg K/liter than for plants fertilized with 75 mg·liter⁻¹. No differences in r_m (data not shown) were detected among plants grown at the various K fertilizer concentrations over the two days, indicating differences in Pn were stomatal in nature.

Potassium fertilizer concentration did not influence ψ_L among treatments at any one observation time during the study (data not shown). However at 1100 HR on day II, all plants fertilized with 75 mg K/liter and several plants with K at 300 mg·liter⁻¹ wilted at mean ψ_L of -0.84 and -1.08 MPa , respectively. None of the plants with 600 mg

K/liter wilted; they had a mean ψ_L of -1.09 MPa .

Mean total shoot dry weights were 4.8, 5.6, and 4.5 g for plants fertilized with 75, 300, and 600 mg K/liter, respectively. Total leaf area was 15% greater for plants with K at 300 mg·liter⁻¹ than for those grown with 75 or 600 mg K/liter.

These results suggest increasing K fertilizer concentrations may improve the tolerance of *Salvia* to moisture stress by reducing transpirational water loss and allowing Pn to continue to lower ψ_L . However, K at 600 mg·liter⁻¹ improved moisture stress tolerance at the expense of plant growth. Before recommendations can be made for use of increased K fertilizer concentrations, other K-salt fertilizers, concentrations, and their impact on the environment must be evaluated.

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Fig. 1. Transpiration (top), leaf conductance (center), and net photosynthesis (bottom) per unit leaf area of *Salvia splendens* 'Bonfire' during the onset of moisture stress as influenced by K fertilizer concentration. Mean separation was made within each measurement time by Tukey's studentized range (HSD) test at $P = 0.05$.

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