

Heat Tolerance in Perennial Salvias
(Student)

F. Todd Lasseigne, Stuart L. Warren, Frank A. Blazich,
and Thomas G. Ranney
NC State University, Dept. of Horticultural Science,
Raleigh, NC 27695-7609

Nature of Work: The genus *Salvia* L. comprises approximately 900 species of shrubs and perennial, biennial, and annual plants of cosmopolitan distribution. In recent years, many of these species, and cultivars derived from hybridization and selection, have been introduced into cultivation in American gardens (2). However, limited information is available on heat tolerance of salvias now cultivated. Only *S. splendens* Sell. ex Roem. & Schult. has been studied extensively, due to its importance as a bedding plant.

Of the species of *Salvia* that are grown currently in the southeastern U.S., two groups can be designated: (A) European species and derived cultivars [*Salvia* x *sylvestris* L. 'Mainacht' (usually translated as "May Night") and *S. nemorosa* L. 'Ostfriesland' (translated as "East Friesland")] and (B) Latin American species and derived cultivars [*S. leucantha* Cav. ("Mexican bush sage"), *S. greggii* A. Gray ("Texas sage" or "autumn sage" or "cherry sage"), *S. guaranitica* St.-Hil. ex Benth. ("blue anise sage"), and *S. chamaedryoides* Cav. ("blue oak sage" or "germander sage")]. On average, European *Salvia* are believed to prefer cooler, moister conditions than the Latin American (especially the Mexican) *Salvia*, many of which are adapted to hot, sunny sites. Therefore, the objective of this study was to quantify the range of heat tolerance existing among a diverse group of perennial salvias.

Rooted stem cuttings of *S. x sylvestris* 'Mainacht', *S. nemorosa* 'Ostfriesland', *S. leucantha*, *S. greggii* 'Furman's Red', *S. guaranitica*, and *S. chamaedryoides*, and seedlings of *S. splendens* were grown in pots [10.2 cm x 10.2 cm x 36 cm (4 in x 4 in x 14 in)] containing a medium of 1 sand:8 pine bark (by vol.) at varying temperatures. Instead of using a factorial arrangement of treatments, which would limit the number of taxa that could be tested, increasing day temperatures were combined with both a "cool" or a "warm" night temperature over a 15-hour photoperiod. Temperature treatments were 15-hour day temperatures of 20, 25, 30, 35, and 40 °C (68, 77, 86, 95, and 104 °F), in combination with 9-hour night temperatures of 15 ("cool") or 25 °C ("hot"), yielding 10 different temperature combinations. Plants were fertilized with a modified Hoagland's solution every other day and were watered on alternating

days with distilled water. The experimental design was a randomized complete block with eight replications of each temperature treatment, for a total of 80 plants per taxon.

Temperature treatments were initiated October 6, 1997, and the experiment concluded November 10, 1997, for a duration of 35 days. At the conclusion of the experiment, dry weights of leaves, stems, and roots were determined, except for plants of *Salvia greggii* 'Furman's Red' for which only shoot and root dry weights were recorded. Data were subjected to analysis of variance procedures.

Results and Discussion: Plants of all seven taxa grown at 25 and 30 °C appeared normal and exhibited no visual stress symptoms, regardless of night temperature. However, stunting of growth was observed in selected *Salvia* at 20 °C. Symptoms of heat stress were apparent in many taxa at 35 °C, and were observed in all taxa at 40 °C; although the severity of symptoms varied by taxa. Symptoms appeared as general stunting, followed by foliar chlorosis, distortion, and necrosis, which progressed from leaf margins toward the central area of the blade. By the end of the experiment, most plants of *Salvia splendens*, *S. guaranitica*, and *S. chamaedryoides* were dead in the 40°C chamber.

Among all taxa, shoot dry weights were significantly affected by day temperatures (Fig. 1A). The day temperature x night temperature interaction was nonsignificant for all measured variables in all taxa. Quadratic trends across increasing day temperatures were observed for *S. leucantha*, *S. splendens*, *S. guaranitica*, *S. chamaedryoides*, *S. x sylvestris* 'Mainacht', and *S. nemorosa* 'Ostfriesland'. *Salvia greggii* 'Furman's Red' exhibited a weaker quadratic response and showed decreased shoot growth with increasing temperature. Response of root dry weight to day temperature was similar to shoot dry weight, except that data were nonsignificant for *S. nemorosa* 'Ostfriesland' and *S. x sylvestris* 'Mainacht' (Fig. 1B). Root dry weight of *S. chamaedryoides*, *S. greggii* 'Furman's Red', and *S. guaranitica* decreased linearly with day temperature, whereas *S. leucantha* and *S. splendens* showed quadratic responses.

To our surprise, *Salvia x sylvestris* 'Mainacht' and *S. nemorosa* 'Ostfriesland' displayed the greatest heat tolerance. Of the caulescent species, *S. greggii* 'Furman's Red' appeared to be the most heat tolerant, followed by *S. leucantha*, although the plants appeared weak and spindly at 35 and 40 °C. The most heat intolerant caulescent species were *S. chamaedryoides*, *S. guaranitica*, and *S. splendens*. Observations of severe damage due to high temperature stress were observed in *Salvia splendens* at 30 and 35 °C. All plants of *Salvia splendens* were dead in

the 40 °C chamber by the conclusion of the experiment. The lack of observed heat tolerance in the Mexican caulescent *Salvia* taxa was unexpected.

Significance to Industry: Unlike the extensive work which exists on cold hardiness, the role of heat tolerance in limiting the geographic distribution and adaptability of ornamental landscape plants remains poorly understood. However, recent efforts, such as the American Horticultural Society Plant Heat-Zone Map (1), are adding much-needed climatic data upon which a better understanding of heat tolerance will ultimately be based. The critical information which is thus-far lacking centers around plant responses to high-temperature-induced stress (as well as any interactions with other concomitant stresses). The results presented herein with salvias clearly show wide variations in responses to high temperatures that can occur within a single genus. The most heat tolerant taxon was *Salvia xsylvestris* 'Mainacht', and the least heat tolerant taxon was *S. splendens*. Future work will focus on these differences to elucidate specific parameters that allow one *Salvia* to be better adapted to high-temperature stress than another.

Literature Cited:

1. American Horticultural Society. 1997. The American Horticultural Society plant heat-zone map. Amer. Hort. Soc., Alexandria, VA.
2. Clebsch, B. 1997. A book of salvias: Sages for every garden. Timber Press, Portland, OR.

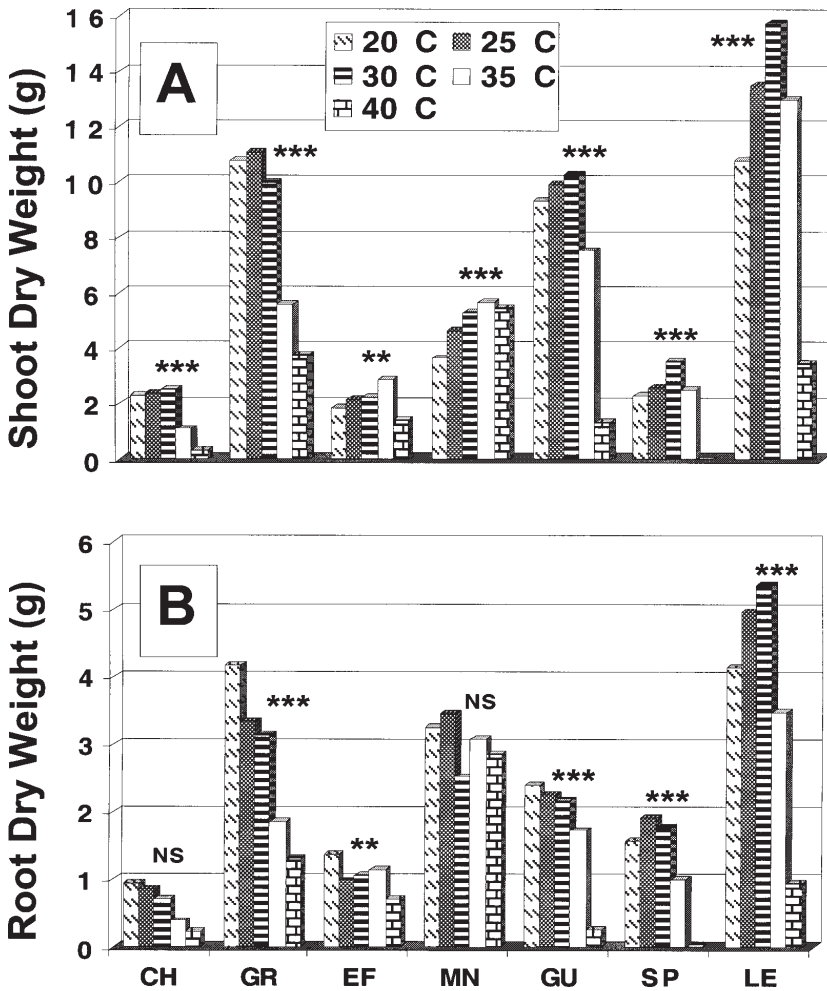


Fig. 1. Effect of day temperature ($^{\circ}\text{C}$) on shoot (A) and root (B) dry weights of selected taxa of *Salvia*. Legend A applies to both figures.

NS, **, *** Nonsignificant or significant at 0.01 or 0.001 probability levels, respectively.

CH = *Salvia chamaedryoides*

GR = *S. greggii* 'Furman's Red'

EF = *S. nemorosa* 'Ostfriesland' (East Friesland)

MN = *S. \times sylvestris* 'Mainacht' (May Night)

GU = *S. guaranitica*

SP = *S. splendens*

LE = *S. leucantha*