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Partial Shade, Irrigation, and Added Nutrients Maximize Dry Matter Yield of American Skullcap (*Scutellaria lateriflora* L.)

Arsène Similien
Agricultural Division, SEED Ministries Inc., P.O. Box 32, Warf-Massé, Les Cayes, Haiti, West Indies

Dennis A. Shannon[1], C. Wesley Wood, and Edzard van Santen
Department of Agronomy and Soils, 202 Funchess Hall, Auburn University, AL 36849

Nirmal Joshee
Agricultural Research Station, Fort Valley State University, GA 31030

Wheeler G. Foshee
Department of Horticulture, Auburn University, AL 36849

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***Abstract*. American skullcap (*Scutellaria lateriflora* L.), a medicinal plant species valued for its sedative properties associated with flavonoids, is generally harvested from the wild. Scientific information on how field cultivation practices affect dry matter yield is lacking in this species. A 2 × 2 × 3 split plot factorial experiment within a randomized complete block design was conducted on a Marvyn loamy sand (fine-loamy, kaolinitic, Thermic Typic Kanhapludults) in Central Alabama to explore effects of light, irrigation, and nutrient application on dry matter yield of American skullcap. Treatment factors were shade (40% shade vs. no shade), irrigation (applied at 30 kPa vs. no irrigation), and nutrients [no added nutrients vs. nutrients added as chemical fertilizer (100 kg nitrogen, 68 kg phosphorus, 42 kg potassium/ha) or chicken litter (100 kg nitrogen, 50 kg phosphorus, and 123 kg potassium/ha)]. Shade formed the main plot units, whereas irrigation × nutrient factorial combinations were subplots. Skullcap shoots in experimental plots were harvested four times during the course of the two-year experiment (2007, 2008). All growth variables measured, except percent dry matter, performed better under shade than in full sun. Dry matter yield was increased 45% by shade, 61% by irrigation, and 22% by addition of nutrients. A significant irrigation × nutrients interaction was observed at the first and second harvests. Highest yields were obtained with the irrigation + manure and irrigation + fertilizer treatments under shade and the lowest with fertilizer and the control treatments in full sun.**

Before the advent of synthetic medicines, plants were a main source of medicine (Mannfried, 1993). A resurgence in the use of herbal medicine (Azaizeh et al., 2005) creates a need to cultivate medicinal plants traditionally harvested in the wild. Benefits of cultivation of medicinal plants include uniformity of herbal material and prevention of incorrect identification, adulteration, and loss of the wild gene pool (Azaizeh et al., 2005; Sturdivant and Blakley, 1999).

American skullcap (*Scutellaria lateriflora* L.) was traditionally used by Native Americans to treat many illnesses (Wills and Stuart, 2004). Currently, the herb is mainly used for its sedative properties (Upton, 2009) and is in high demand in the herbal products industry (Brevoort, 1998). American skullcap is naturally found in moist and wooded areas (Awad et al., 2003; Foster and Duke, 2000) and is classified as a facultative wetland plant (USDA, 2011). The plant has been grown successfully in full sun and partial shade (Janke and DeArmond, 2004; Joshee et al., 2002). Most research on American skullcap has focused on identifying and extracting chemical constituents present in the plant tissues (e.g., Awad et al., 2003; Bergeron et al., 2005). Field experiments on *Scutellaria baicalensis* were reported by Zheljazkov et al. (2007); however, there is no report of agronomic experiments conducted on American skullcap under field conditions in the United States. The two species differ considerably in adaptation, and *S. lateriflora* is cultivated for aboveground leaves and stem, whereas roots are harvested in case of *S. baicalensis*.

The objectives of this research were to 1) evaluate the potential for American skullcap to be successfully grown under regular farming practices; and 2) determine growing conditions needed to optimize total dry matter yield. Factors tested were light, water, and nutrients. The effect of the growing conditions tested on flavonoid content in skullcap will be reported separately.

Materials and Methods

Site description and land preparation. The experiment was conducted at the Horticulture Unit of the E.V. Smith Research Center, near Shorter, AL, on a Marvyn loamy sand (fine-loamy, kaolinitic, Thermic Typic Kanhapludults), 2% to 5% slope. Soil pH measured in Dec. 2006 before liming and on 22 Mar. 2007 10 d after liming were, respectively, 5.1 and 5.8 with a cation exchange capacity of 4.6 $cmol_c \cdot kg^{-1}$.

Before tillage, weeds were controlled using 2.1 kg glyphosate herbicide (Roundup) a.i./ha. A preliminary tillage operation was done in Mar. 2007 using a disk harrow. After the first tillage and after liming, five soil samples were taken from each experimental block at a depth of 0 to 15 cm to determine pH and primary nutrients [nitrogen (N), phosphorus (P), and potassium (K)] content. A second tillage operation was done on 9 Apr. 2007 using a RHINO SHV80 rototiller to loosen the soil. Dolomitic limestone was applied at the rate of 2500 $kg \cdot ha^{-1}$ in Mar. 2007 before the second tillage and before bedding. Chemical fertilizer and chicken litter were hand-broadcasted on respective plots on 6 Apr. 2007 before bedding. An 18-inch wide bedder (Reddick Fumigants, LLC, Williamston, NC) was used to prepare beds and place drip irrigation lines simultaneously on 10 Apr. 2007. Beds were covered with weed guard groundcover manufactured from ultraviolet-resistant black polyethylene to help control weeds while allowing air and water to reach the plant root system. Holes ≈5 cm in diameter were cut at a spacing of 30 cm × 30 cm to allow for transplanted seedlings. Pine bark mulch was spread over the fabric to help control weeds between and on beds. On 7 Apr. 2008, immediately after emergence of new foliage in Year 2, the mulch fabric was removed from all plots to allow stolons, which had spread under the fabric, to grow shoots.

Experimental design and treatments. The experiment was a 2 × 2 × 3 split plot factorial in a randomized complete block design (r = 4). The shade factor formed the main plot units, whereas irrigation and nutrients were subplots. Subplots measured 1.2 × 6.1 m (7.43 m^2) and each subplot consisted of 40 plants. Seedlings were spaced 30 × 30 cm, yielding a population density of 53,800 plants/ha assuming a full stand. Single drip lines 16 mm inner diameter, 250-mm wall, 30-cm spacing between drippers, 340 L/H flow/100 m at 0.55 bars pressure were installed down the center of each bed. The two irrigation levels were none and irrigation

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[1]To whom reprint requests should be addressed; e-mail shannda@auburn.edu.