Agave sisalana Perrine

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Introduction

Agaves are often associated with the alcoholic beverages tequila (produced from A. tequilana) and mescal (produced from A. salmiana and other species). Agave sisalana Perrine is known for its fiber production, and is commonly known as “sisal” or “sisal hemp”. It is the primary agave cultivated for fiber in eastern Africa, Brazil, India, and various countries in Asia. In the first half of the twentieth century, sisal supplied about 70 percent of the world’s long hard plant fibers (Nobel 1994). The fibers run the entire length of the leaves, which can grow to five feet, and have been used for rope, twine, nets, upholstery padding, carpet pads, blankets, baskets, jewelry, sandals, clothing, fish stringers, musical instruments, ceremonial objects, construction material, paper pulp, and even dart boards (Nobel 1994). Although sisal is native to Mexico, commercial hard fiber from Mexico is produced primarily from henequen (A. fourcroydes) and lechuguilla (A. lechuguilla). According to Nobel (1988), A. sisalana was exported from Mexico in the 19th century and formed the basis of fiber industries in Indonesia, the Philippines and, in the 20th century, East Africa. Later, Mexico prohibited the export of the plant to protect its own fiber industry but, by then, plants were available in Florida, having been imported and established by Dr. Henry Perrine (Morton 1952, Nobel 1994, Trelease 1913). Nobel reports that 1,000 bulbils were sent from Florida to Germany in 1893. Bulbils are young plantlets, usually at least four inches in length, that occur on the inflorescence and can be planted directly in the soil. Approximately 200 bulbils survived the trip and 62 survived the ensuing trip to German East Africa (now Tanzania). Within five years, these plants multiplied into 63,000 starter plants for large plantations in Tanzania, Kenya, Mozambique and Uganda. These plantations eventually supplied approximately half of the world’s hard fiber (Nobel 1988, 1994). By the early 20th century, A. sisalana also was cultivated in India, Southeast Asia, many Pacific islands, and Australia (Nobel 1988).

Origin of Agave sisalana

The genus Agave was established by Linnaeus in 1753 and contains approximately 136 species in the Agavaceae family (Nobel 1988). Agaves are native to North America, with their center of origin in present-day Mexico (Gentry 1982, Nobel 1988). Gentry reports that the “origin of Agave sisalana is uncertain. Because it was originally exported from Mexico via the port of Sisal in Yucatan, it has long been erroneously reported as of

Field reports

Agave sisalana Perrine, commonly known as sisal hemp, is on the FL-EPPC Category II list of invasive species. According to a FL-EPPC database search in January 2002, there were 24 field reports for this species, with the most reports coming from Dade County (7), followed by Monroe County (5), Martin (4), Palm Beach (3), Lee (2), Broward (2) and Sarasota (1). Lee County leads in acreage reported at 600 acres, followed by Martin at 84, Monroe at 34, and Broward at 19. However, only 7 of the 24 field reports included estimates of acreage. Of the 15 density estimates provided, one “dense monoculture” was reported in Dade County, one in Sarasota County, and one in Monroe County. All other density estimates were “scattered plants.” The University of South Florida’s online Atlas of Florida Vascular Plants (www.plantatlas.usf.edu/), which is based on vouchered herbarium specimens, lists Agave sisalana in Brevard, Manatee, Lee, Collier, Monroe, Dade and Martin counties, (i.e. it lists specimens in 3 counties not listed in FL-EPPC field reports (Brevard, Manatee, and Collier), while FL-EPPC has field reports for 3 counties not listed in the online atlas (Palm Beach, Broward, and Sarasota.)
Yucatan origin. However, no botanical collections of the plant have ever been made in Yucatan, and botanists who have worked in Yucatan have told me they did not find the plant there."

Fiber plantations in Yucatan are reported to be henequen, Agave four-croydes. Residents in the neighboring state of Chiapas grow Agave sisalana as fence rows and for fiber, which is made into rope, nets, hammocks, and other functional items. Gentry states that the “occupation appeared indigenous and, since this is the only area in which A. sisalana has been observed and regularly employed in the village complex, I regard the area as a likely place of origin.”

Growth of Agave

Gentry describes Agave sisalana as a sexually sterile clone, probably of hybrid origin, due to its general inability to produce seed and by its chromosomes. He also notes that night temperatures of 24-25°F (-5°C) often cause leaf “burn” and dieback. Nobel (1994) reports that sisal grows best on free-draining non-saline soils, and that in regions of Kenya and Tanzania with 1200 millimeters of rainfall per year (similar to Florida’s range of from 1000 to 1,500 millimeters per year), A. sisalana has a total above-ground dry weight productivity of about 20 tons per hectare per year. Under plantation conditions, A. sisalana produces about 220 leaves per plant before the emergence (referred to as “bolting”) of the 5-6 meter high inflorescence at about seven years of age (Nobel 1994). Leaves can be harvested after two years of age, which will postpone the “bolting” for 15-20 years. After “bolting”, the plant dies.

The United States Sisal Trust

The United States Sisal Trust was a company (ca. 1919) organized to develop and grow sisal commercially in south Florida. According to a brochure for the company, 22,400 acres of land in Dade County (Florida City) were to be developed into a plantation, 10,000 acres of which was to be devoted to sisal production. 750,000 plants were grown in a nursery to supply the first unit of 1,000 acres. The expected market for the sisal was American farmers who needed “binder twine, rope and other cordage.” The brochure for this company states that 220,000 tons were imported into the U.S. in one year, primarily from Mexico, Cuba and the Bahama Islands. The company intended to capitalize on this market. The brochure goes on to describe the introduction of sisal into south Florida:

"The first sisal plants in Florida were introduced at Indian Key in the year 1826 by Dr. Henry Perrine, American Consul at Campeche, Yucatan, who applied for and received from the United States Government a grant of a township of land conditioned upon its being planted to this product. Later the Indians murdered him and drove his family away. A few years later Mrs. R.V. Carpenter, who lives four miles south of Miami gathered a number of these plants from the Perrine grant and planted them at her home overlooking Biscayne Bay at Coconut Grove. From these original plants others have been set out as ornaments all over Dade County, and as far north as Jupiter. A large number being recently planted for ornamental purposes at the entrance of the palatial home of James Deering in the city of Miami, where they are seen to thrive on rock walls and fences without practically any soil."

The advent of synthetic fibers during and after World War II severely depressed the natural fiber industry and many plantations failed or were converted to other crops. Current attempts to boost the economic returns of sisal cultivation include research
into uses for leaf pulp by-products and sap.

Agave in the Literature

Following are some of the more interesting and unusual citations found on *Agave sisalana* in the scientific journal literature. The wide ranging list covers research from Oribatid mites to the invasion of sandy beachfronts to electrical behavior of fibers to perme-thrin-impregnated sisal curtains to mushroom cultivation to toothbrush sticks to an Olduvai skull.


"Another species collected from Guandong and Guangxi Provinces formed many spots on the leaf surface of *Agave sisalana* which were cultured in the field." Banerjee, A.K. (1972) Trial of *Agave* species in lateritic areas of West Bengal. *Indian Forester* 98(7):432-436.

Battanoff, G.N., Franks, A.J. (1997) Invasion of sandy beachfronts by ornamental plant species in Queensland. *Plant Protection Quarterly* 12(4):180-186. "In this study, the most important factors contributing to ornamental weed invasions are human assisted plant introductions through the dumping of garden plants into native vegetation."


Githoko, A.K., Adungo, N.J., Karanja, D.M., et al. (1996) Some observations on the biting behavior of *Anopheles gambiae* s.s., *Anopheles arabiensis*, and *Anopheles funestus* and their implications for malaria control. *Experimental Parasitology* 82(3):306-315. "Studies were carried out in three villages in western Kenya on the biting behavior of *Anopheles gambiae* s.s., *Anopheles arabiensis*, and *Anopheles funestus*. … Under the influence of perme-thrin-impregnated sisal curtains placed under the eaves of village houses, there was a marked egress of blood-fed *A. funestus* and *A. gambiae* s.s."

Grob, K., Artho, A., Biedermann, M., et al. (1993) Contamination of hazelnuts and chocolate by mineral oil from jute and sisal bags. *Zeitschrift fuer Lebensmittel Untersuchung und Forschung* 197(4):370-374. "Before spinning, jute and sisal fibres are treated with a batching oil commonly consisting of a raw material oil fraction. Such oil is transferred to foods packed into jute or sisal bags, i.e. primarily cocoa beans, hazelnuts, coffee, almonds, oil seeds, and rice."

Gupta, R.K., Agarwal, M.C., Joshi, P. (1997) Phenotypic stability of *Agave* species on bouldery wastelands (riverbed) of Doon Valley. *Indian Forester* 123(4):331-337. "*Agave sisalana* was found to be the only stable *Agave* species and hence could be recommended for mass adoption on bouldery wastelands of Doon Valley."


Hartmann, A. (1997) Anthropogenic output of major nutrients under monocropping sisal in Tanzania. *Land Degradation and Development* 8(4):305-310. "Much more nitrogen was lost from the topsoil than can be explained by the nutrient balance, indicating significant losses."


Izaguirre-Mayoral, M.L., Mary F., Olives, E., et al. (1995) Effect of seasonal drought and cactus X virus infection on the cressulacean acid metabolism of *Agave sisalana* plants growing in a neotropical savanna. *Journal of Experimental Botany* 46(287):639-646. "Healthy and cactus X virus infected *Agave sisalana* plants were collected during the dry and rainy seasons in two contrasting savanna sites."


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**NOT Targets for Control in Florida: Two Endemic Agaves**

Natural resource managers in central and south Florida may encounter the invasive exotic *Agave sisalana*, sisal hemp, in coastal middens, thickets, or hammocks, the common habitats of two uncommon native agaves: false sisal, *Agave decipiens*, and wild century plant, *Agave neglecta*. With only a little practice, though, the target invasive is easily distinguished from these endemics.

False sisal, found in the Keys and mostly the southwest peninsular coast, has relatively narrow leaves (5-10 cm), and the leaves are concave or cupped, with margins bearing regularly spaced, conspicuous recurved (hooked) prickles. The more rare wild century plant, known from three counties, has broad leaves (20-25 cm wide) that are concave, with straight margins bearing numerous close, minute prickles. Sisal hemp leaves are around 10 cm wide, flat, and usually smooth on the margin, with no prickles on, or just a few tiny ones. Other characters differ as well, but these are easy ones for novice agave lovers and haters.

— K.C. Burks, Invasive Plant Mgt., Florida DEP
**Herbarium Specimens**

The paucity of herbarium specimens for *Agave sisalana* is likely due to the difficulty of preparing a specimen from a large succulent plant with sharp one inch points on the tips of leaves that grow up to five feet long. In addition, the inflorescence can grow to thirty feet tall and six to eight feet in diameter.

To learn how to prepare such a difficult specimen, go to the web site of Southern Illinois University Herbarium: Botanical Potpourri (www.science.siu.edu/herbarium/potpouri/prepare.htm) where detailed instructions are available under the heading “Suggested Techniques for Preparing Hard to Prepare Herbarium Specimens.” A section on succulent xerophytes covers Agave specimens. Use caution when working with Agave; the juice or sap, which contains saponin and oxalic acid, is reported to cause skin irritation and eye damage (Perkins 1978; Morton 1995).

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**References:**


