Arecaceae—Palm family

Serenoa repens (Bartr.) Small

saw-palmetto

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Synonym. *Serenoa serrulata* (Michx.) Nichols.

Growth habit, occurrence, and use. Saw-palmetto usually is an evergreen shrub, 0.6 to 2.1 m tall, with creeping, horizontal stems. Occasionally, the species attains the size of a small tree, reaching a height of 1.8 to 2.3 m, with an erect or oblique stem (Bailey 1976; Vines 1960). The common name, saw-palmetto, derives from the ascending, palmate leaves, which are rather stiff and have long petioles heavily armed with sharp, rigid, recurved teeth. These armed petioles are capable of severely scratching the skin and ripping clothing and shoes.

Saw-palmetto occurs from coastal South Carolina southward to Florida and westward to eastern Louisiana (Bailey 1939). It reaches its most extensive development in the pine flatwoods of the lower coastal plain of Georgia and Florida. Along Florida's eastern seaboard ridge grows a silver leaf variety that is highly prized for ornamental use. Saw-palmetto occurs in highest densities in flatwoods that have been burned annually or biannually (Abrahamson 1984).

Saw-palmetto provides wildlife habitat for over 100 animal species (Carrington and others 2000; Hilmon 1986). Fatty acid extracts from the partially dried, ripe fruits (called "serenoa") are used as a phytotherapeutic agent in treating certain irritations of the bladder, prostate gland, and urethra (Ganzera 1999; Vines 1960). In some places, the large fan-shaped leaves (fronds) are used to thatch roofs on temporary structures, and larger stems are occasionally used for crude logs.

Large quantities of saw-palmetto leaves are shipped north for Christmas decorations; the flowers are a significant source of honey; and the stems are a source of tannic acid extract (Vines 1960). Saw-palmetto is increasingly used as a landscape plant to provide a naturalistic effect.

Flowering and fruiting. The numerous, small, white flowers are borne in panicles that emerge in February and March in southern Florida and in April in southern Georgia (Carrington and others 2000; Hilmon 1968; Vines 1960). The panicles appear on branches that are shorter than the leaves. The inflorescences and vegetative branches arise from buds identical in their position in the leaf axil and indistinguishable in their early development. In an adult plant, as much as 50% of the axillary buds abort; of those remaining, most (~80%) become inflorescences and the others (~20%) become vegetative suckers (Fisher and Tomlinson 1973). The inflorescence bud's first leaf is called a prophyll and its mouth splits as younger bracts grow through it; subsequent bracts are distichously arranged and encircle the main axis of the inflorescence (Fisher and Tomlinson 1973).

The flowers are perfect with 6 stamens, 1 stigma within 1 style (Radford and others 1964). Several thousand flowers per inflorescence are produced from buds at the bases of the previous year's leaves. Saw-palmetto plants must be at least 60 cm high to flower in the wild

(Carrington and others 2000). The number of leaves produced per year after a disturbance is a good indicator of flowering.

Fire stimulates the initiation of inflorescences in sexually mature saw-palmettos by reducing the canopy and thus increasing light availability. Although a burn at any time of year stimulates flowering within 1 year of the fire, frequent burning reduces flower and fruit production. Two sites of 40 saw-palmetto plants were studied in a 6-year period and burned every 2 years. The plants flowered 36 times, with approximately 40% flowering occurring within 1 year of burning (Hilmon 1968). Saw-palmetto plants flowered 65% of the time following a burn on flatwood sites, and 85 to 90% bloomed after 2 or 3 burns (Abrahamson 1999). On scrub stand sites, saw-palmetto flowered 56% after a prescribed burn, 62% after the second-season burn, then returned to preburn levels (12%) by the third season after burning (Abrahamson 1999). The saw-palmettos produced more inflorescences per plant following the second and third fires. To maximize flower and fruit production, a site should be burned no more than every 4 years (Abrahamson 1999; Hilmon 1968). Stands of saw-palmetto on scrub and sandhills that had not been burned in a long time had relatively closed canopies and low reproductive frequencies (16%).

Cultural treatments have been used to stimulate flowering. Fertilizer (10% N, 5% P_2O_5, 5% K_2O) and dolomite lime (49% $CaCO_3$), 36% $MgCO_3$, and 10% Mg) applied at a rate of 155 g per plant around the plant's drip line, did not influence flowering. But when crowns were clipped and plants fertilized, there was a significant elevation in flowering during the second growing season: 18% flowering in treated plants compared to 4% flowering in control plants (Abrahamson 1999). Saw-palmettos that were only clipped had a 22% flowering response.

The fruit is a drupe measuring about 1.5 to 3 cm long and 15 to 20 mm in diameter, that is ovoid-oblong, green or yellow before ripening, and bluish to black when ripe (Hilmon 1968; McCurrach 1960; Vines 1960) (figure 1). Immature green fruits are present from May through July, turn orange by August, and ripen to bluish-black in September and October (Carrington and others 2001). Each drupe contains a single globose seed (figures 1 and 2), and the embryo is laterally oriented (Bailey 1976).

Each inflorescence typically produces 4 to 5 kg (9 to 11 lb) of fruits (Vines 1960) and can produce up to 12 kg (27 lb) in a good year (Carrington and others 2000). The average fruit yield for a site is 200 kg/ha; yields can vary from 150 kg/ha to over 1,500 kg/ha (Carrington and others 1997).

In Florida, anthracnose infection—by *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.—has been identified as a major factor (90%) in fruit loss. The remaining 10% of the loss is caused by a caterpillar (*Atheloca* sp.) (Carrington and others 2001).

Collection of fruits. In south Florida, fruit harvesting begins in August, when fruits turn orange. In south Georgia, harvesting begins in early September, when fruits begin to turn black. The fruits are collected by snapping the panicles by hand, cutting them with pruning shears, or shaking the attached fruits into burlap bags, plastic sheets, or the bed of a truck. Seeds are available commercially within the natural range of the species.

Extraction and storage of seeds. Palmetto fruits can be dried in the sun or in indoors in bins or tobacco barns. The fruits are piled about 0.6 to 1.0 m high (Carrington and others 2000). Fruits are dried at 54 EC (not to exceed 60 EC) for about 3 days; fruits in bins are turned every 12 hours (Carrington and others 2000). The initial moisture content is about 66% fresh weight; the fruits are then dried to a maximum of 10% for storage.

Large suppliers store the freshly harvested fruits in wet tanks holding 100,000 kg (250,000 lb). The berries are conveyed to a stainless steel dryer with a capacity of drying 300,000 kg (750,000 lb) per day. The dryer takes an hour to dry a batch of fruits, thus, preserving more of the fatty acids used for phytopharmoceuticals. After drying, a blower is used to remove leaves, stems, and other trash (SPHC 2002).

Seeds must be extracted from the fruits or germination will not occur, even after 222 days (Hilmon 1968). If high temperatures (35 EC) are maintained throughout the germination period, dried fruits will germinate in a greenhouse (Perkins 2002). Seed may be extracted by running the fruits through a macerator or other suitable device for separating the seeds from the pulp. Dried saw-palmetto fruits average 720/kg (326/lb); the dry seeds average 2,380/kg (1,081/lb)(Hilmon 1968).

Steel silos holding 100,000 kg (250,000 lb) are used for storing dried fruits. In a "low-tech" method, the dried fruits are stored in burlap bags and housed where they will not freeze. Seeds stored dry at room temperature for 3 months retained their viability (Hilmon 1968). After 1 year of storage, viability drops slightly; after the second year, viability drops about 50% (Perkins 2002). No tests of seed storage under a variety of conditions or different time periods have been reported.

Pregermination tests. Pregermination treatments of saw-palmetto seeds indicate that they require high temperatures throughout the germination period. Pretreatment temperatures (25, 35, and 45 EC) were significantly different for maximum germination and days to 50% final germination. Average germination for all treatments at 25 EC was 52.3% and 72 days to 50% final germination; germination at 35 EC was 60.8% and 47 days to 50% final germination; and germination at 45 EC was 41.9% and 61 days to 50% final germination (Carpenter 1986). Non-imbibed seeds required significantly more time to achieve 50% final germination than did imbibed seeds at 25, 35, and 45 EC. Seed weights increased from 34 to 39% for imbibed seeds (Carpenter 1987). Seedlots that were soaked for 7 days in water or peat moss reached 50% final germination in 39.8 and 33.7 days at 35 EC, with maximum germination values of 75 and 80%, compared to lots of un-imbibed seeds, which took 53 days to 50% final germination with 46% germination (Carpenter 1987). Soaking seeds in water for 7 days at 35 EC resulted in 10% higher germination and 27 days earlier germination when compared with soaking seeds in water at 25 EC (Carpenter 1986). There was also a 20% higher germination at 35 EC and 15 days earlier germination when compared with 45 EC soaking temperature (Carpenter 1986). There was no significant difference in germination and days to 50% final germination between seeds soaked for 7 days in water were compared to seeds stored in damp peat moss for 7 days at 25, 35, and 45 EC (Carpenter 1986). There was no interaction in germination response between temperature and seed soaking treatments.

All seed treatments resulted in lower germination values than those of controls at each temperature. The germination over all temperatures dropped from 76% for no treatment to 13% for a 15-minute soak in sulfuric acid (H_2SO_4). Seed embryos were injured and killed by soaking in the acid for 15 minutes and to a lesser degree for 5 minutes (Carpenter 1986). Gibberillic acid and mechanical scarification treatments did not increase the total germination or reduce the days to 50% of final germination. Seed germination was reduced and delayed by 15 minutes of scarification (Carpenter 1986). The germination temperatures used in experiments Carpenter (1986 and 1987) were 34 and 21EC with bottom heat at 30 EC provided to the propagation medium in the greenhouse. Seeds were planted 6 cm deep in clean builders' sand.

Germination tests. Germination tests were made with fresh seedlots treated in several ways—with and without pulp, endocarp intact and crushed, or with embryo and endosperm exposed (Hilmon 1968). Only extracted seeds germinated. The tests were made on moist filter paper with daytime temperatures of 26 to 28 EC and nighttime temperatures of 13 to 22 EC. Seeds with the micropyle cap removed and the embryo exposed began to germinate in 11 days; it took seeds with the cap intact 45 to 66 days to germinate. After 222 days, however, the germinative capacity of all extracted seeds was similar and ranged from 50 to 60%.
In another test, 5 replications of 20 seeds each from 3 different seed sources were tested under conditions nearly identical to those just described (Hilmon 1968). First germination occurred between 45 and 66 days. A period of slow germination was followed by a period of rapid germination (optimum period), during which approximately half of the seeds germinated. Optimum germination began 4½ to 6 months after planting. Germinative capacity after 231 days ranged from 65 to 85%, and all ungerminated seeds appeared viable. The germination temperatures used in the experiments cited above (Carpenter 1986, 1987) were 34 and 21 EC, with bottom heat at 30 EC provided to the propagation medium in the greenhouse. Seeds were planted 6 cm deep in clean builders' sand.

Nursery practices. Freshly cleaned seeds are placed in large vats for a week to ferment. Without rinsing, the seeds are sown 1.25 to 2.5 cm (½ to 1 in) deep in a seedbed in the greenhouse. Dried seeds are soaked in water for 5 to 7 days at 32 to 38 EC before they are sown in the seedbed. Seeds should not be sown until the nighttime temperature is constantly above 21 EC. Germination of fresh seeds averaged from 50 to 70%, compared to that of dried seeds, which averaged 30 to 50% .The first leaf of the seedling emerges above the soil 1 to 2 months after germination (Fisher and Tomlinson 1973). It takes 90 days to reach peak germination in the greenhouse (Perkins 2002).

After peak germination, the seedlings are transplanted to liners in a well-drained medium and grown with liquid fertilizer for 6 months. They are then transferred to 3.8-liter (1-gal) containers to grow for 12 to 16 months. The final step is transplanting the saw-palmetto into 11.4-liter (3-gal) containers to grow 12 to 16 months before they are finally ready to sell (Perkins 2002). Slow-release fertilizers are used for both sizes of containers.

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Figure 1—*Serenoa repens*, saw-palmetto: fruit and seed, H 2.

Figure 2—*Serenoa repens*, saw-palmetto: longitudinal section through a seed, H 3.