

Seed Germination Methods and Establishment of Saw-Palmetto, *Serenoa repens*, in South Texas

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Abstract

Saw-palmetto, *Serenoa repens*, a native of Florida rangelands, and used medicinally in prostate formulations, was evaluated as an alternative crop in semi-arid, subtropical South Texas (Lat. 26°8'N, Long. 97°57'W). Fresh seeds, obtained from the USDA Plant Introduction Station, Miami, Florida, were sown on 28 Oct. 1999 directly into artificial media after using the following pre-germination protocols: (1) fruit 'as is', (2) seed with mesocarp removed (cleaned seed), (3) seed cleaned and rinsed for 24h then imbibed in water for an additional 24h, (4) seed cleaned and rinsed for 24h + 6h acid scarification, then rinsed in water for an additional 18h, (5) seed cleaned and rinsed for 24h + mechanical abrasion, then imbibed for 24h, (6) seed cleaned and rinsed for 24h + GA_{4,7} (100 µg L⁻¹) soak for an additional 24h, and (7) seed cleaned and rinsed for 24h and a combination of procedures 4 + 5. After 12 weeks, treatments 3 through 7 were, statistically, but not kinetically, similar (50-61% germination), but higher than simply removing the mesocarp (20%) or planting the unprocessed seed (8%). These seedlings were then grown in a greenhouse until 14 March 2001, pooled, and field planted into a Fine, mixed, hyperthermic Vertic Calciustolls and a Coarse-loamy, mixed, hyperthermic Aridic Haplustalfs soil (USDA). Plants were set at 0.9 m within row spacing, in single 36 m rows, trickle irrigated, and supplied with fertilizer each year. First flowering was observed in 2003. The yield per plant and plant height were 229 and 1007 g and 1.6 and 1.9 m, for 2005 and 2006, respectively, for plants grown in the two respective soils (means were different at $P < 0.01$). Using the above seed germination protocols, proper site selection, agronomic inputs, control of pests (weeds and wildlife), 3.6 t/ha of seed could be expected from a commercial *S. repens* planting (3588 plants/ha) by the 6th year.

INTRODUCTION

Saw-palmetto, *Serenoa repens* (Bartr.) Small [*S. serrulata* (Michx.) Nichols], is a 1 to 7 m palm (Arecaceae) found from the coastal plains of South Carolina, along the Gulf States of Alabama and Mississippi to Florida in the USA. Fruits are high in antiprostatic compounds and have found use in natural formulations for the treatment of benign prostatic hyperplasia. An estimated 6.8 t of the fruit are gathered from the wild and shipped to Europe each year (Bennett and Hecklin, 1998). There would be advantages to the domestic cultivation of medicinal plant species, such as *Serenoa repens* (Franke and Kirsch, 1994). A sampling of three price competitive internet sites in Sept. 2006 were offering powder or whole berries (to include certified organic) for \$17.84 to \$26.43 (US) per kg.

Saw-palmetto seed have low and slow germination rates. Carpenter (1987a) evaluated pre-germination storage temperatures and seed moisture treatments prior to sowing and found that soaked or imbibed seed held for 1 week at 35°C provided the highest germination when seeds were subsequently planted in sterile quartz media kept at 30°C in a greenhouse. Treating *S. repens* seeds with GA₃ or scarified either with H₂SO₄ or mechanically before soaking did not improve germination (Carpenter, 1987b).

My objectives were to validate or improve existing germination methods for *S. repens* and to determine if it could be grown as a cultivated medicinal crop in S. Texas.

MATERIAL AND METHODS

Seed of *S. repens*, which were originally collected in 1978 in Florida and cataloged as MIA 25211 by the USDA, ARS National Genetic Resources Program, were obtained from the Miami, Florida repository 15 Oct. 1999. Upon receipt, seed were separated into seven treatment protocols consisting of: (1) fruit (entire drupe), as is; (2) cleaned (mesocarp removed) seed, as is; and in subsequent treatments 3 to 7, cleaned seed was washed by continuous water rinse for 24h, then (3) additional 24h water soak; (4) acid scarification w/ 0.4 N HCl for 6h, rinse for 18h + additional 24h soak; (5) mechanical abrasion + 24h soak; (6) GA_{4,7} (100 g L⁻¹) for 24h soak; and (7) treatment 4 (w/ immediate rinse) + treatment 5 and 18h soak. All soaking in deionized water was done in 250 ml flasks w/ moderate motion on a platform shaker.

Treated seed were placed on the surface of 3.78 L pots containing Sunshine Mix #5, covered with 1 cm layer of fine vermiculite, and then clear plastic film. There were 15 seeds per pot (treatment) and each treatment replicated 4 times. Pots were placed in an incubator (34°C) for 3 weeks, then moved to a greenhouse and arranged in a Randomized Complete Block design, and then 9 weekly emergence counts and a final count at week 22 were taken.

At the termination of the germination experiment, individual seedlings were transplanted into 3.78 L nursery pots containing Sunshine Mix #1 and kept 12 months in a greenhouse. On 14 Mar. 2001, plants were randomly selected and field planted into two soil types, one a Fine, mixed, hyperthermic Vertic Calciustolls (heavy soil) and the other a Coarse-loamy, mixed, hyperthermic Aridic Haplustalfs (light soil) (USDA). Plants were spaced 0.9 m apart in single 36 m rows in each soil type, trickle irrigated, and supplied with inorganic fertilizers, as needed each year. Weeds were controlled mechanically. Fruit yield and plant height measurements were begun in 2005 and 2006, respectively. Weather data were collected within 60 m of the field plots.

RESULTS AND DISCUSSION

Germination

Protocols 3 to 7 improved final seed germination compared to unclean fruit and unwashed seed by 7- and 2.5-fold, respectively (Table 1). Acid scarification plus mechanical abrasion resulted in the highest initial germination after 3 weeks (treatment 7), but soaking seed in GA_{4,7} resulted in the highest average weekly germination rate. Simply soaking cleaned seed for 48h provided germination rates equivalent to treatments 4 to 7. None of the additional inputs (protocols 3 to 7) were statistically different in final germination at the 22nd week, although their rate of germination between weeks 3 and 12 did vary (Fig. 1).

Field Performance

Physical and chemical properties of the light and heavy textured soils are described in Table 2. Environmental data for the six year period are summarized in Table 3. First flowering was observed in 5 to 10% of the plants in 2003 (data not shown). Fruits were first collected beginning in 2005. The fruit yields obtained in 2005 were higher (P<0.01) from plants grown in the light textured soil compared to those grown in the heavier soil (Table 2). In 2006, fruits were harvested on three dates (Julian dates 229, 264, and 319). The pooled season plant yield was slightly higher in plants grown in the lighter textured soil (P<0.20), but the JD 229 yields were significantly higher (P<0.02), suggesting that the lighter textured soil may stimulate early season flowering and berry yield. Plant height, measured in 2006, was greater in plants grown in the lighter textured soil. Although plant height was reported and not stem growth, plant development may still be considerably higher when *S. repens* is grown under cultivation compared to stem

growth observed in the wild (Tanner et al., 1999). Plants grown in the wild are subject to periodic fire, caused either naturally or deliberately set for brush control in grazed rangelands. *S. repens* generally requires 4 to 5 years after a fire event to resume normal fruit production (Tanner et al., 1999). Thus, commercialization of *S. repens* from the wild, could result in an improved and consistent supply of this medicinally important seed at reduced consumer cost.

CONCLUSIONS

Germination of *S. repens* can be improved by removal of any fleshy material around the seed, washing the seed, and soaking the seed in water for 24h before sowing in a germination medium. Scarification methods and GA were of no additional benefit. When grown under cultivation, a lighter textured soil results in improved plant height by 20% and increased fruit yield of at least 2-fold by the 6th year, and appeared to promote earlier season fruiting. Thus, a planting of 3588 plants/ha could generate up to 3.6 t/ha in the 5th or 6th year of the planting.

Literature Cited

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Tables

Table 1. Final 22 week percent germination and the rate of germination during weeks 3 through 12, inclusive, for the seven pre-germination protocols.

Treatment	Germination (%)	Germination rate (y) ¹	
		intercept x	slope b
1	8.3 b ²	-0.02111	0.00626
2	20.0 b	0.02222	0.00838
3	53.3 a	0.09333	0.05152
4	53.3 a	0.14444	0.04404
5	55.0 a	0.20000	0.04000
6	61.7 a	0.16000	0.05273
7	50.0 a	0.21889	0.03051

¹ Where $y = x + b$ (week).

² Mean separation in column by Ryan Multiple Range test, $P=0.01$.

Table 2. Chemical and physical attributes of soils at the planting site.

Soil	Chemical analysis (in kg/ha)												
	Ca	K	Mg	Mn	P	S	Na	Fe	NO ₃	Zn	Cu	B	Al
Hebbronville ¹	2012	442	317	73	54	9	26	58	5	1.0	2.2	0.5	638
Raymondville ²	12940	1200	526	142	107	201	123	41	13	4.3	4.0	3.3	767

Soil	Chemical and physical attributes								
	pH	E.C. (dS·m ⁻¹)	N	Total (%)		Bulk Density	Texture (%)		
			Org. C	Carbon			Sand	Silt	Clay
Hebbronville ¹	7.6	0.08	0.03	0.25	0.30	1.51	47	42	11
Raymondville ²	8.2	0.22	0.07	0.63	1.64	1.24	20	34	46

¹Hebbronville: Course-loamy, mixed, hyperthermic Aridic Haplustalfs.

²Raymondville: Fine, mixed, hyperthermic Vertic Calcistolls.

Table 3. Environmental plot data near Weslaco, Texas (Lat. 26°8'N, Long. 97°57'W) for the period 2001 - 2006.

Year	Temperature (°C)		Rainfall (cm)
	Max.	Min.	
2001	41.5	-2.5	49.5 ¹
2002	41.5	-3.8	63.2
2003	42.9	-1.4	69.0
2004	42.2	-3.4	77.3
2005	43.4	0.2	44.1
2006	41.5	-0.4	52.3

¹Beginning on 14 Mar. 2001.

Table 4. Field performance of *S. repens* in two soil types.

Soil type ¹	Plant height (m)	Yield / plant (g)
2005		
Light textured	-	1007 A
Heavy textured	-	229 B
Prob. > 'F' value		0.01
2006		
Light textured	1.93 A	330 a
Heavy textured	1.59 B	146 b
Prob. > 'F' value	0.002	0.20

¹Light textured soil: Course-loamy, mixed hyperthermic Aridic Haplustalfs.

Heavy textured soil: Fine, mixed hyperthermic Vertic Calcistolls.

Figures

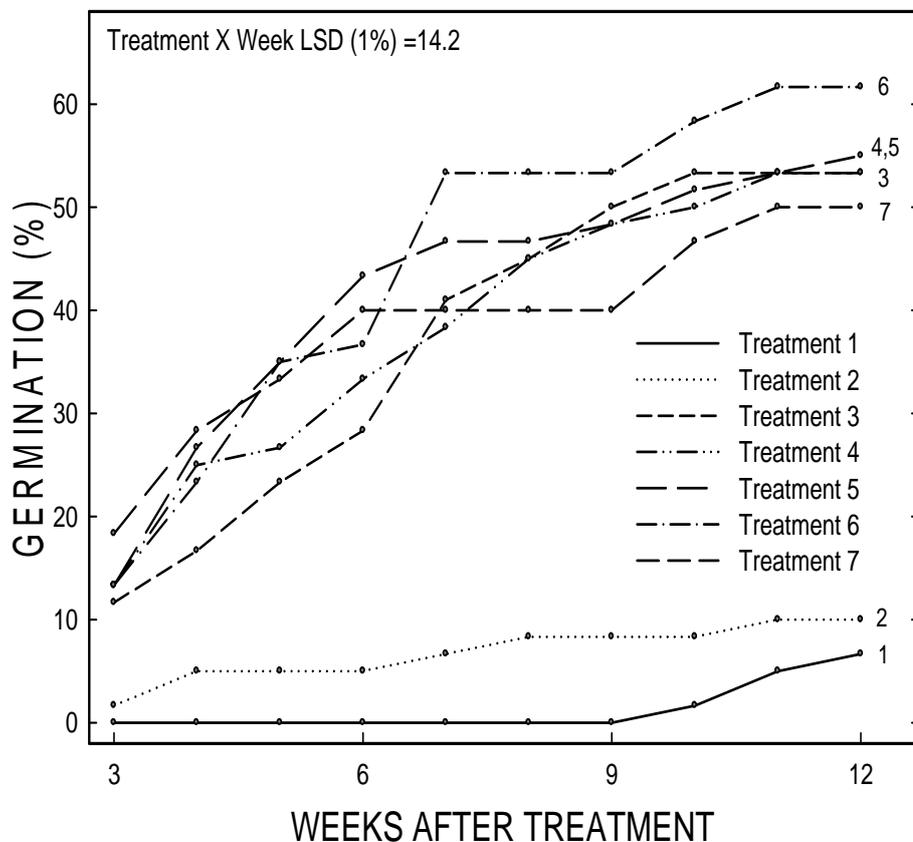


Fig. 1. Germination of *S repens* seed between weeks 3 and 12 following 3 week incubation at 34°C. Treatments: (1) fruit, as is, (2) cleaned seed, as is; remaining seed were washed for 24h, then (3) 24h additional soak, (4) acid scarification, (5) mechanical abrasion, (6) GA_{4,7}, and (7) treatments 4 + 5.