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Characteristics and Germination BehaviorOf *Sterculia setigera* (L.) Del. Seeds

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ABSTRACT

Sterculia setigera (Tartar) a multipurpose savanna tree is a priority tree species for conservation in Sudan. This study aimed to evaluate seed characteristics and germination behavior of *Sterculia setigera* seeds. Tartar seeds were collected from two sources (crown and ground) from El Nour forest in Blue Nile State. Seed characteristics and the standard germination test were determined following ISTA Rules (1993). Comparison of seed parameters means was performed using Student's t-test. To assess the response to pregermination treatments Tartar seeds were subjected to the following treatments: aril removal; soaking in tap water for 72, 48 and 24 hours; soaking in boiling water for 10 and 5 minutes and control (untreated seeds). Seeds from both sources were sown in a germination cabinet under controlled conditions and the germination behavior was evaluated over a period of five weeks. A completely randomized design with four replicates arranged in a factorial setting (2×7) was used. Results on moisture content percentage classified Tartar seeds as orthodox. The effect of seed source on morphometric characters, size index and shape index was significant *($p<0.05$).* There were no significant ($p>0.05$) differences between the two seed sources in total germination percent whereas germination rate was found to be significant only in week 2. Significant ($p<0.05$) differences in germination were observed across the treatments. Aril removal and soaking in tap water for72, 48 and 24 hours significantly increased the germination percentage giving 79,5% ,65.5%.74.2% and 67.1% respectively , compared to the control (32%).

Introduction:

Sterculia setigera of family Steruliaceae is found in Senegal, in the Sudan-Sahel and in the Sudan-Guinea zone (Maydell, 1990). In Sudan *sterculia setigera*, locally known as Tartar, is wide spread deciduous species in savanna woodland in the rainfall of 600 – 1000 mm (El Amin,

1990). The tree grows up to 15 m tall and has papery peeling bark (Vogt, 1995). It is a multipurpose tree and has various medicinal uses. The tree is universally accepted as one of the main contributing sources of world's commercial gum karaya. The tree can be considered as a potential source for gum karaya production in Sudan if attention is paid to its domestication and management (Coppen, 1995).The potential economic importance of the species justifies its identification as a candidate for urgent domestication. Although *Sterculia setigera* trees produce numerous seeds (El Amin, 1990), natural regeneration of the tree is rare and the species remain under among the most endangered species. The autecology of the species was not studied in Sudan and only meager data in seed and germination characteristics are available. Thus focusing attention and provision of information on the germination of this important species becomes a necessity.

Determination of seed characteristic is essential in identification and processing procedures of seeds. It is also important in calculation of seed demand for a given afforestation program. Seed testing is an analysis of some physical and physiological quality of seed lot based on a small representative sample. It includes a number of parameters such as seed weight, purity, viability moisture content and germination. High physiological seed quality is necessary for obtaining high germination capacity and vigor (Schmidt, 2000). Seed quality is a major factor in the economic success and productivity of a forest project (Kleztzov and Iorova, 2001).

There are many methods for seed collection ranging from simple collection from the ground to advanced methods using sophisticated equipment. However an optimal seed quality is a precondition in selection of the method to be utilized (Schmidt, 2000). *Sterculia setigera* seeds can be collected directly from crown of standing trees or can be collected from the ground from beneath the mother tree or from under resting trees of birds where large amount of regurgitated seeds are found. Seeds that fall to the ground under mother trees are readily susceptible to attack by insects, while seeds collected after bird-dispersal are less likely to be attacked.

International Seed Testing Association (ISTA,1993) defined germination of a seed in a laboratory test as the emergence and development of the seedling to a stage where the aspects of its essential structures indicates whether or not it is able to develop further into a satisfactory plant under favorable conditions in soil. Seed dormancy is a state in which viable seeds fail to germinate under conditions of moisture, temperature and oxygen normally considered to be adequate for germination (Willian, 1990; and Schmidt, 2000). Several internal factors cause dormancy which includes seed coat, embryo, or inhibitors, which influence the seed germination rate (Agrawal and Dadlani, 1995). For the breaking of dormancy a variety of seed treatments proved to be effective (Larcher, 2003; Smith, 1986; Gordon and Rowe, 1982, Alamgir and Hossain, 2005; Azad *et al*., 2011; Zubairu, 2014). Mechanical scarification renders the seed coat permeable to water so that imbibition can take place. Soaking in water either cold, hot or boiled is done to modify hard seed coats, remove inhibitors, soften seeds and reduce germination time.

The objective of this study is to investigate the effect of seed sources variation and pregermination treatments on seed and germination characteristics of *Sterculia setigera* in Sudan.

Materials and Methods:

Seed materials:

Seeds of *Sterculia setigera* were collected from El Nour forest, East Eldamazin City in the Blue Nile State, Sudan. (Lat. 11° 49′ N, Long. 34° 29′ E). seeds were obtained from two sources: fresh seeds collected directly from crowns of standing trees (referred to as crown source) and seeds collected after bird dispersal from under resting trees of birds (referred to as ground source). A

working sample of about 5 kg was drawn for each seed source. Seed and germination tests were carried out in the in the National Tree Seed Research Centre at Soba (Lat. 15° 36′ N, long. 36° 55′ E), Sudan.

Seed characterization:

Seed moisture content was determined on fresh weight basis following the oven method described in the ISTA Rules 1993. The cutting test was used to determine the number of sound and dead seeds. 200 seeds were taken at random from the working samples and divided into two lots. Seeds were cut transversely one by one using a pruning shear and examined with the naked eye and the percentage of sound seeds was, then, determined. Physical purity was determined according to the ISTA Rules 1993. Four samples each weighing 35 gram were randomly taken and visually examined to separate foreign bodies and the percentage of pure seeds was calculated. The biochemical tetrazolium test method (TZ) was used to examine seed viability. Four samples of 50 seeds each were used. Seeds were cut longitudinally through the embryo and soaked in 1% 2,3,5, triphenyltetrazolium solution in petri dishes and kept in dark for 24 hours. Viable seeds go red in color and dead seeds remain uncolored. The percentage of viable seeds was then recorded. Seed length and width were measured using a sensitive vernier. Seed shape index and size index were calculated as length divided by width and length multiplied by width, respectively. Seed weight and number of seeds per kilogram were obtained according to ISTA Rules 1993. Students' t-test was used to analyze the data.

The standard germination test (ISTA, 1993) was used to assess the germination potential of *Sterculia setigera* seeds. The experiment was carried out in a germination cabinet under controlled light and temperature conditions (12 hours photoperiod, minimum temperature 27 C and maximum temperature 30 C). A completely randomized design with four replicates was used. One hundred seeds from each source were taken randomly and divided into four replicates of twenty five seeds each. Seeds were sown in germination trays filled with sterilized sand and water daily to keep the germination media moist. Data on germination were recorded on daily basis for a period of 5 weeks. Total germination percent and germination rate (percentage of the germinated seeds /week) were calculated.

Effect of pregermination treatments on germination of *Sterculia setigera* seeds:

Seeds of *sterculia setigera*, from both sources, were subjected to seven different treatments as follows: aril removal, soaking in tap water for 24, 48 and 72 hours, soaking in boiling water for 5 and 10 minutes and the control (untreated seeds). A completely randomized design with four replicates arranged in a factorial setting (2×7) was used. The treatment combination consisted of two factors, namely seed source and pregermination treatments. The total number of seeds tested was 1400 (2×7×4×25). Seeds were sown in germination trays filled with sterilized sand and water daily to keep the germination media moist. Data on germinated seeds were recorded weekly over a period of five weeks. For both germination experiments analysis of variance was carried out using SAS statistical software version 9 (SAS Institute Inc., 2002) to determine the significance in variations among treatments. Duncan Multiple Range Test was used to separate between means.

Results and discussion:

Seed characteristics:

The t-test results (Table 1) showed insignificant difference in moisture content between the two seed sources (P=0.24). The values for crown (6.73%) and ground (6.56%) seed sources agree with the figure of 6.2% given by Eljack (1999) but higher than the value of 4.3% for *Sterculia*

pallen reported by Mustafa *et al*. (1986). The values obtained are in the range of 1.7 - 9.7% moisture content for 17 species of Steruliaceae family (Gaydou, *et al*., 1993). According to the results of this study *Strculia setigera* seeds can be classified as orthodox. Orthodox seeds are dry seeds with moisture content less than 8% and have good storability characters (Stubsgaard and Poulsen, 1995). The cutting test, which is simple, quick and easy, offers essential information about the status of the seed lot. Insignificant difference was observed between the two seed sources in soundness percentage (Table 1). Seeds of *Sterculia setigera* are infested by insects right after they fall to the ground. The high percentages (99,25%, 98.50%) of sound seed in both resources (Table 1) might indicate that seeds collected from these sources are less susceptible to insect attack. Purity test revealed significant difference between the two sources of seeds (p = 0.01). Crown source seeds were 100% pure while about 2.50% debris and inert materials were mixed with seeds collected after bird dispersal.

The t-test results on seed weight and morphometric characters given in Table 1 revealed significant variation in mean of all seed characters measured except for seed length. seed length (1.31, 1.30 cm) for crown and round sources respectively (Table 1) is comparable to the value of 1.22 cm given by Eljack (1999) and within the range of (1.0- 1.4 cm) reported by Sahni (1968). Seeds collected from tree crown were heavier and thicker than those collected from the ground. Differences in size index and shape index were significant between the two methods used for seed collection (P = 0.01).

Table (1) characteristics of *Sterculia setigera* seeds

Seed character	Crown Source		Ground Source		T value	P > |T|
	Mean	S.E ±	Mean	S.E ±		
M.C,%	6.56	0.12	6.73	0.05	1.36	0.24
Soundness %	99.25	0.48	98.50	0.65	0.94	0.39
Purity %	99.95	0.01	97.43	0.14	18.44	0.01
Viability %	95.30	.055	94.0	0.73	1.14	1.75
Length(mm)	13.08	0.01	13.02	0.01	1.84	0.07
Width(mm)	0.81	0.01	0.9	0.01	69.58	0.01
Size index	1.6	0.01	2.21	0.02	-59.03	0.01
Shape index	28.64	0.26	27.78	0.16	2.28	0.02
Weight(g)	28.64	0.26	27.78	0.16	2.28	0.02
No./kg	3493	31.65	3600	21.09	-2.81	0.02

The standards germination test

Analysis of variance results on the standard germination test revealed no significant differences (*p >0.05*) between the two seed sources in total germination percentage. Although *Sterculia setigera* seeds have high soundness percentage, yet both seed sources gave poor germination of 36% and 30% for crown and ground sources respectively (fig,1). This low observed result could probably be attributed to the presence of a kind of dormancy rather than other environmental factors. For both seed sources germination commenced during the first week and ceased by the end of week four.The peak in germination rate was encountered in week three for both seed sources (fig. 2).

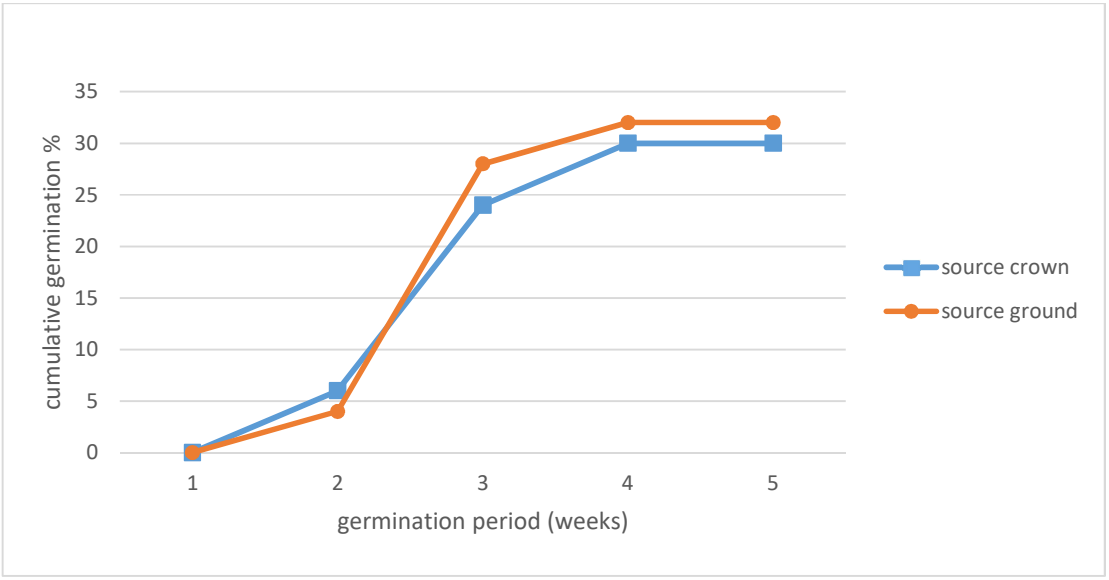

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Figure: 1 Standard germination curve of *Stercula setigera* seeds

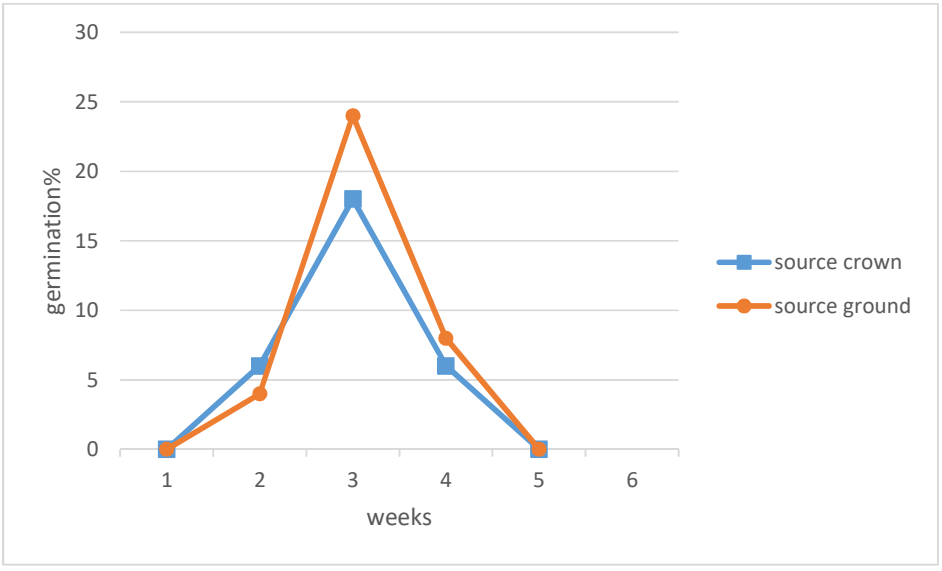

Figure: 2 Germinability of *Sterculia setigera* seeds during five weeks

Effect of seed source and pregermination treatments on germination percentage

ANOVA results showed insignificant ($p<0.05$) effect of seed source on mean total germination percentage. Both sources gave almost similar germination percentages (56.4%, 57.0%) (Table 2).

Table (2) Effect of variation of seed source and pregermination treatments on mean germination percentage of *Sterculia setigera* seeds.

Treatment	Seed source Crown	Ground	Mean
Aril removal	80.0 a	79.0a	79.5a
Soaking 72 hours	68.0ab	63.0ab	65.5a
Soaking 48 hours	76.5ab	72.0a	74.2a
Soaking 24 hours	61.2ab	73.0a	67.1a
Boiling 10 mins	46.9b	44.0c	44.0b
Boiling 5 min	35.0c	47.0bc	41.0b
control	28.0d	37.0c	32.0c
Mean	56.4[a]	57.0[a]	

Means in a column followed by the same letter are not significantly different at p<0.05 using Duncan Multiple Range Test. Means with similar superscripts within a row are not significantly different (P < 0.05).

Results of the study has apparently showed a significant *(P<0.05)* effect of pregermination treatments on germination capacity of *Sterculia setigera* seeds. This is explained by the apparently observed high seed germination responses to aril removal of 80% and 79% for crown and ground seed sources respectively, compared to the control that gave 28% an 37% (Table 2). Such variation could probably be related to the presence of some kind of dormancy in *Sterculia setigera* seeds. The highest germination percentage obtained by seeds subjected to aril removal treatment is similar to the value of 81.3% for Tartar seeds reported by Hussein and El Nour (2003).This result is supported by Hartmann *et al.* (1997), who stated that manual scarification is effective in breaking physical, mechanical and chemical dormancy. However it should be carried out in such a way not to damage the internal tissues of the seed. Results of the present study showed that immersing Tartar seeds in cold water for 24, 48, and 72 hours enhanced germination by breaking the seed coat. The values of soaking for 48 hours (74.2%), 72 hours, (65.5%) and 24 hours (67.1%) were significantly higher than those obtained from untreated seeds and seeds treated with boiled water (Table 2).These results are supported by the findings of Kramer and Kozlowski (1979), Hartmann *el al.* (1997) Owonubi et al. (2005) and Rasebeka *et al*. (2014) who reported that placing seeds in cold water increase the imbibition phase of germination and break their dormancy. Breaking seed coat dormancy by scarification breaks the seed coat and allow the seed to imbibe water. Imbibition of water after breaking the seed coat is known to trigger germination (Aliero, 2004), whereas water may not be available to the embryo in the untreated seeds. The result of soaking for 24 hours is higher than the value of 50.6% given by Hussein and El Nour (2003). The observed reduction in germination percentage under 72 hours prolonged soaking compared to 48 hours soaking may be related to accumulation of some toxic materials which hinder germination (Kramer and Kozlowski, 1979; Bannister, 1976). Compared to the control hot water treatments produced higher germination percentage of 44.0% and 41.0% for boiling 10 and 5 mins respectively. Soaking in boiled water makes the seed coats permeable to

water and the seeds imbibe and swell as the water cools. Hot water treatment has yielded beneficial results with a number of leguminous seeds (Mwase and Mvula, 2011).

Cumulative germination rate:

Analysis of variance revealed insignificant *(p< 0.05)* differences in seedling cumulative germination rate between the two seed sources in all weeks except in week two. The effect of seed treatment on seedling emergence percentage was found to be significant in all weeks except in week one (table 3). During the second week the highest seed emergence percentage was obtained by seed treated by soaking in water for 24 hours, whereas in week three the treatment of soaking 24 hours and 48 hours and aril removal were significantly higher than other treatments. Seed emergence from both seed sources commenced in all treatments during the second week. Aril removal and soaking in water for 72, 48, and 24 hours treatments were significantly different from the remaining treatments. Seed emergence ceased at week four for all treatments except for aril removal and soaking in water for 24 hours treatments which terminated in the last week.

Table (3) the effect of seed source and pregermination treatments on cumulative germination rate of *Sterculia setigera* seeds

	Mean germination %				
Seed source	Weak1	Weak 2	Weak3	Weak4	Weak5
Crown	0.1a	12.3a	36.2a	57.5a	57.5
Ground	0.1a	7.7b	33.7a	53.9a	55.8a
Treatment					
Aril removal	0.0a	10.0bc	35.5ab	73.5a	79.0a
Soaking 72 hours	0.0a	6.0c	29.0b	62.5a	62.5a
Soaking 48 hours	0.0a	15.5b	50.0a	71.5a	73.5a
Soaking 24 hours	0.0a	20.5a	48.5a	68.0a	68.0a
Boiling 10 min	0.0a	5.5c	26,0b	42.5b	42.5b
Boiling 5 min	0.5a	3.5c	32.5b	39.5b	39.5b
control	0.5a	9.0bc	32.0b	32.5b	32.5b

Means in a column followed by the same letter are not significantly different at p<0.05 using Duncan Multiple Range Test.

Conclusion:

Based on the results presented, it is clear that the seeds of *Sterculia setigera* need pre-sowing treatment to enhance germination. The results also found that the type of seed dormancy is physical dormancy (seed coat dormancy). Manual scarification by aril removal or soaking seeds in cold water for 48 hours can be used to pre-treat Tartar seeds in order to break the impermeable seed coat and allow the embryo to imbibe water and hence enhance the germination of the seeds.

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