ASSESSMENT OF PRE-SOWING TREATMENTS ON THE SEED GERMINATION OF *ADANSONIADIGITATA LINN (BAOBAB) IN THE SAVANNAH REGION OF NIGERIA*

Salami, K. D, Jibo, A. U, Lawal, A. A, Ahmad, U and Harisu, S.
Department of Forestry and Wildlife Management, Faculty of Agriculture, Federal University Dutse, Jigawa State, Nigeria
Corresponding Author: foristsalam@yahoo.com

Abstract
Adansoniadigitata Linn is a plant with hard seed coats, endangered nature and its need for sustainable livelihood is unavoidable. Therefore, there is the need to determine the best silvicultural methods that can enhance the of propagation of this species. This study was therefore conducted to investigate the pre-germination treatmentsas it affects the growth and development of Adansoniadigitataseedsin the nursery at the Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa State. The seeds were subjected to four (4) pre-sowing treatments namely: soaking in cold water for 48 hours (T_1), soaking in hot water for 30 minutes (T_2), soaking in concentrated Tetraoxosulphate(vi) acid (H_2SO_4) for 35 minutes in 20ml (T_3) and the no treatment - control (T_4). The experiment was laid out in Completely Randomized Design with twenty seeds sown for each treatment making a total of hundred seeds. The results of the pre-sowing treatments showed that there were significant differences ($p \leq 0.05$) across the four treatments applied on seeds. Acid treated seeds had the highest performance (95%), followed by hot water treatment (40%). The study therefore recommends soaking of Adansoniadigitata seeds for 35 minutes in 20ml of acid for mass production of seedlings. This will enhance the early growth and performance of this species.

Keywords: *Adansoniadigitata, Germination, Pre-sowing treatments, Tetraoxosulphate (vi) acid (H_2SO_4)*

Introduction

*Adansoniadigitata*is one of the most important Non-Timber Forest Product (NTFP) providing species with significant ecological and socio-economic significance. It is among the nine global species of baobab in the genus *Adansonia*from the family Malvaceae and subfamily Bombacaceae (Salami and Lawal, 2018a). Its vernacular name, 'baobab' which is used globally, is derived from the Arabic name “buhibab” meaning fruit with many seeds (Diop*et al.,* 2006). The genus name *Adansonia*is used in honor of a botanist, Michel Adanson (1727–1806), whilst the species, *digitata*(hand-like) was in reference to the shape of its leaves (Esterhuyse*et al.,* 2001). Apart from *Adansoniadigitata*which is native to Africa; there is the Australian baobab, *Adansoniagibbosa, A. Cunnand*and six other baobab species native to Madagascar namely *A.grandidieri*Baill. *A.madagascariensis*Baill., *A. rubrostipa*Jum and H. Perrier, *A. perrieri*Capuron, *A. suarezensis*H. Perrier. and *A.za* Baill. Which is the most widespread baobab in Madagascar (Sidibe and Williams, 2002). The ninth species that was recently discovered in Africa through morphology, ploidy and molecular phylo genetics research is *A. kilima*(Pettigrew *et al.*, 2012). *A.kilima*was found to be superficially similar to *A. digitata*though it could be differentiated on the basis of floral morphology, pollen characters and chromosome number (Pettigrew *et al*., 2012). *Adansoniadigitata*, in this case the baobab, is one of the widespread multi-purpose tree species in Southern Africa. It is popularly known as “Africa's upside-down tree” due to its structure. Throughout its range, baobab is making significant contribution to people's livelihoods for food, fibre and medicine (Kamatou*et al*, 2001; Wickens and Lowe, 2008;Venter and Witkowski, 2009). Baobab trees form an important source of income, especially in the dry season and during times of drought (Duvall, 2007; Sidibe and Williams, 2002). According to Sidibe and Williams (2002), baobabs have an outstanding ability to withstand severe drought and fire, which are two major hazards to plant life in dry areas of Africa. Although baobabs are mostly regarded as fruit-bearing trees, they are multipurpose, widely-used species with medicinal properties, numerous food uses of various plant parts, and bark fibers that are used for a wide range of purposes (Dhillion and Gustad, 2004; Wickens and Lowe, 2008). Up to 300 uses of the baobab have been documented in Benin, Mali, Zimbabwe, Cameroon, the Central African Republic, Kenya, Malawi, South Africa and Senegal, across eleven (11) ethnic groups and 4 agro-ecological zones (Buchmann*et al.,* 2010). The fruits and leaves are harvested and stored for consumption throughout the year (Buchmann*et al*., 2010). Fruit harvesting of baobabs normally starts from April to May in Southern Africa and from October to November in West Africa (Sidibe and Williams, 2002). However, there are some baobab trees that can go for several years without fruiting or that do not produce fruit at all and such baobabs have been categorized as 'poor producers' (Venter and Witkowski, 2011) or in some areas as 'male' baobabs (Assogbadjo*et al*., 2009). Seedgermination in tree species is sometimes difficult due to hard seed coat and dormant embryos (Salami, 2018) and the seeds often fail to germinate even under favourable moisture, oxygen and soil conditions. To overcome this problem, several methods including mechanical scarification, soaking in water and acids (Patane and Gresta, 2006), chilling and heating (Beigh, 2002; Salami and Lawal, 2018b)**.** The present study aimed to determine the germination percentage of different pre-treatment methods in order to prescribe for the nursery officers and plantation establishment.

Ecological Importance

According to Whyte (2001), baobabs are keystone species with ecological significance as they provide important ecosystem services. The tree reduces soil erosion and provides cover or shade with their canopies (Coates-Palgrave, 2002). The vitality of this tree is remarkable as the bark can be completely stripped from the lower trunk and still the tree is able to regenerate new bark (Palgrave, 2002). Their ability to withstand extreme stress from drought allows the trees to be grown on degraded or marginal lands where other species would not survive. Due to climate variability and change, weather extremes are being experienced and as such, the baobab's resilience to such extremities such as drought (Stucker and Lopez-Gunn, 2015) makes it a really vital resource in fulfilling its ecological function and providing essential ecosystem goods. Its spongy wood does not easily burn; therefore, the plant is protected from fire. In areas where the baobab tree grows, there are traditions that prohibit communities from cutting them down, thus such norms play a pivotal role in nature conservation (Kurebgaseka, 2005). Baobab trees add organic nutrients to the soil through leaf fall and through birds and mammals that leave droppings on the ground around the tree trunks (Wickens and Lowe, 2008). In Omusati region, Namibia, pig sites are constructed right at the edges of the baobab trunks to provide shade to the pigs whilst the soil is also being enriched by pigs' droppings. The large white baobab flowers, which open at night, are pollinated by bats and other small mammals and the protection of these pollinators is important for the production of fruits (Whyte, 2001).

According to Sidibe and Williams (2002), the flowers emit a scent that attracts bats. Pollination is therefore majorly by bats. This pollination by bats has been confirmed in studies done in Indonesia as well as West and East Africa (Sidibe and Williams, 2002). The sour scent of the flowers also attracts certain flies and nocturnal moths as well as several species of bollworms that are also involve in pollination (Sidibe and Williams, 2002). The hollow trunks provide shelter to many small animals and birds and offer ideal breeding sites (Whyte, 2001). Many animals such as *Macacafascicularis* (Monkey), *Loxodonta africana* (African Elephant) and birds as well as humans are agents of baobab seed dispersal (Wickens and Lowe, 2008). Baobab tree is an important tree that improves biodiversity by its attraction of various pollinating species. Any decline in baobab population would have an effect on such species (Whyte, 2001).

Economic Importance

According to Sidibe and Williams (2002), fresh and especially dried leaves of this species are sources of revenue to rural women and gardeners in the dry season when other field crop production is low. Baobabs have the potential to provide additional income to farmers especially women and were reported to be one of the tree species with the most valuable food by quantity in markets in Burkina Faso and Mali (Schumann *et al*., 2010). This is supported by Wynberg*et al*. (2012), who found that the residents of Nyanyadzi and Gudyanga sell the baobab fruits in the urban areas or sell the extracted pulp through export or to national confectioneries. According to Wynberg*et al.* (2012), the Overseas Development Institute (2006) projected that the European market for baobab products could initially generate more than US$750 million annually for producer countries in southern Africa per year, making it the highest earner of all traded NTFPs in the region. This therefore means the baobab products have great potential in contributing towards the national economies and improving livelihoods of local communities that own and manage the species. The fibre from the inner bark is particularly strong and durable and is widely used in southern, eastern and western Africa for making ropes, basket nets, snares, mats, fishing rods and for weaving (Sidibe and Williams, 2002). Shells from the fruit and seed cake are usually fed to livestock.

In East Africa, the roots are used to make a soluble red dye whilst the hard fruit shell is used to manufacture containers for food or drink as well as for decorative craft work (Dovie*et al*., 2002). According to Wickens and Lowe, (2008), apart from utilizing the fruit, bark and leaves, the size and shape of the tree lends itself to spaces that can be used for water storage, prisons, toilets, burial grounds, sleeping places, ritual sites and venue for prayers or community meetings among other uses. The Ombalantu Heritage Centre preserves a historical baobab tree which is approximately 1000 years old (Omusati Regional Council, 2010). Baobab tree is approximately 8 m in diameter and about 19 m in height with a hollowed-out trunk that was used as prison during war. The Centre is now a tourist resort where people pay to enter and view the tree and hear about the history of the baobab and also purchase souvenirs from the kiosk.

Medicinal Uses

Baobab leaves, bark, pulp and seeds are used as food and for multiple medicinal purposes in many parts of Africa (Diop*et al.*, 2005). Baobab fruit and leaf are used in folk medicine as an antipyretic or febrifuge to overcome fevers. Fruit pulp and powdered seeds are used in cases of dysentery and to promote perspiration (Sidibe and Williams, 2002). Baobab fruit pulp has traditionally been used as an immune-stimulant (AlQarawi*et al.*, 2003), anti-inflammatory, analgesic, antipyretic, febrifuge and astringent in the treatment of diarrhea and dysentery

(Ramadan *et al.*, 1993). The aqueous extract of baobab fruit pulp exhibited significant hepato-protective activity and, as a consequence, the consumption of the pulp may play an important part in human resistance to liver damage in areas where baobab is consumed (Al-Qarawi*et al*., 2003). Medicinally, baobab fruit pulp is used as a febrifuge and as an anti-dysentery and in the treatment of smallpox and measles as an eye instillation (Wickens, 1979).

In Indian medicine, baobab pulp is used internally with buttermilk in cases of diarrhea and dysentery. Externally, use is made of young baobab leaves crushed into a poultice, for painful swellings (Sidibe and Williams, 2002). Seeds are used in cases of diarrhea, and hiccough. Oil extracted from seeds is used for inflamed gums and to ease diseased teeth (Sidibe and Williams, 2002). Since seed oil is used to also treat skin complaints, it can be considered to have cosmetic applications as well (Sidibe and Williams, 2002). Powdered leaves are used as a tonic and an anti-asthmatic and known to have antihistamine and anti-tension properties. The leaves are also used to treat insect bites, Guinea worm and internal pains, dysentery, diseases of the urinary tract, opthalmia and otitis (Sidibe and Williams, 2002).

Materials and Method

Description of the Study Area

This study was carried out in Forest Nursery of the Department of Forestry and Wildlife Management, Federal University Dutse, Jigawa State. The University falls between latitudes 11.00^{0}N to 13.00^{0}N and longitude 8.00^{o}E to 10.15^{0}E. Theannuallyrainfall is about 743mm. The average annual temperature is 26.5^{0}C.The topography is characterized by high land area which is almost 750meters. Soil tends to be fertile ranging from sandy-loam (Salami and Lawal, 2018c).

Collection of Seeds

Seeds were collected from the mother tree in Jahun Local Government, JigawaState. Seed viability test was carried out by putting the seeds in water and separating those that float as being unviable. Fresh mature fruits of *Adansoniadigitata* were collected, dumped and dried under normal atmospheric condition (Adelani, 2016).

Collection of the Sowing Medium

The top soilused as the sowing medium was collected from the upper level of the earth crust (0-15cm) at the Forestry Nursery Unit of the Federal University Dutse, Jigawa State. The soilwas sieved with 2mm and sterilized at 160^{0}c for 24hours (Adelani*et al*, 2018) and put in plastic germination boxes wherethe seeds were sown.

Pre-germination Experiment

Method and Procedure

Different pre-treatment techniques were used to break the seed dormancy to enhance their potential in absorbing air and moisture during germination. For each pre-treatment, a total of 80 seeds were sown. Treated and non-treated seeds were sown directly in the plastic germination boxes and 20 seeds were sown per container. Watering was done accordingly to provide the containers with adequate moisture. The treatments were arranged in a Complete Randomized Design in three replicates. The pre-germination treatments carriedout on the seeds are stated below:

i. Soaking in cold water (T1): Seed were soaked 400ml cold water at room temperature (28ºC) for 48 hours
ii. Hot water (T2): seed were soaked in 400 ml of boiling water at 100^{0}C for 30mins.
iii. Acid scarification (T3): seed were soaked in 100 % concentrated Tetraoxosulphate (VI) acid (H_2SO_4) for 35mins and were thoroughly rinsed in running water until they are considered to be safe to handle. The treated and non- treated seeds were sown directly in germination box.
iv. Control (T4): Untreated seed were directly sow in the germination boxes

Germination Assessment

Data on germination were recorded daily for a period of six (6) weeks from the date of planting and number seeds sown. Weekly germination percentages were recorded so as to calculate cumulative germination for each treatment. The experiments were carried out in a Completely Randomized Design. The results of the germination studies were subjected to an analysis of variance (ANOVA).

Germination Percentage and Mean Germination Time

Germination percentages were compute using the formula:

$$\textbf{Germination percentage} = \frac{\text{Total seed germination}}{\text{Total seed sown}}$$

Mean germination time was calculated using the formula:

$$Mgt = \frac{\sum(fx)}{\sum x}$$

Where x is the number of newly germinated seed on each day and f is the number of days. X is the total number of seeds that germinated at the end of the experiment. Germination percentage and mean germination time were calculated.

Nursery Maintenance

Regular watering was carried out from ten (10) days before transplanting. Weeding was done manually with the use of hand picking and keeps the surface of the soil loose. This will allow adequate moisture content, air penetration and reduce soil nutrient competition.

Data Analysis

Data collections were subjected to one ways Analysis of Variance (ANOVA) and descriptive statistics (Tables, charts, frequencies and means). Means were compared with the use Duncan Multiple Range Test (DMRT).

Results

The results in table 1 showed that treatment 3 (H_2SO_4) had the highest number of seed germination,19seeds (95%).This is followed by treatment T_2 (Hot water treatment) with germination percentage of forty (40%). T_1 (Cold) and T_4 (Control) had no germination. This implied that cold water treatment and control had no effect on the seed due to hard seed coat. Also, there was no positive performance in the interaction between the volume of soil and fertilizer.

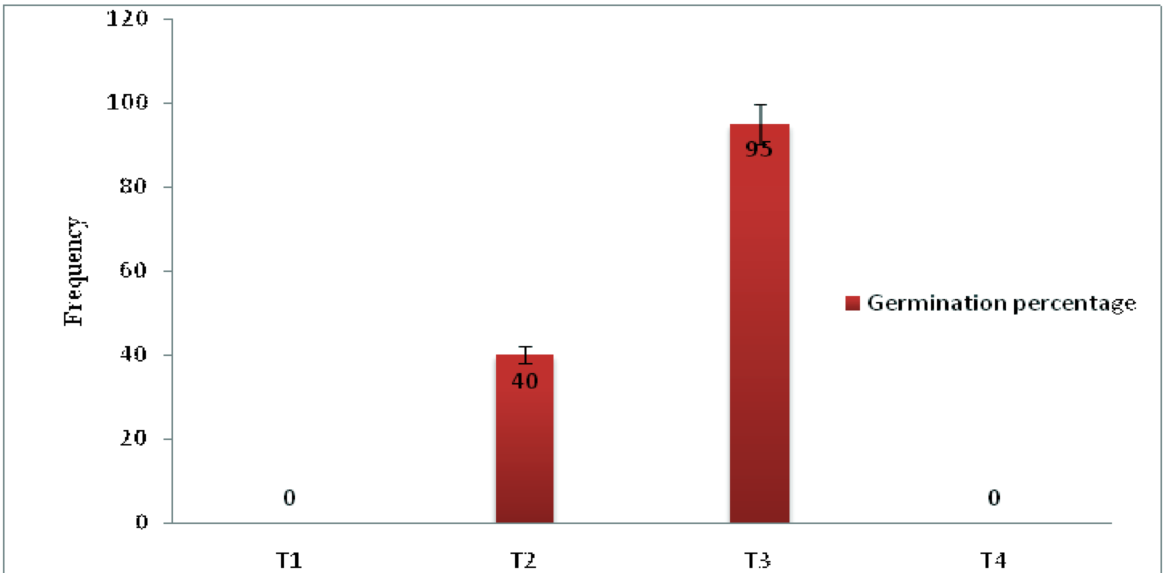

Fig 1: Seed Germination Percentage (%) of Adansonia digitata

Table 1 : Mean Seed germination of *Adansoniadigitate*

Treatment	Mean of germinated seeds
T_1	0.000 ± 0.000^c
T_2	1.333 ± 0.410^b
T_3	3.167 ± 0.838^a
T_4	0.000 ± 0.000^c

Means of the same alphabets along the column are not significant using Duncan Multiple Range Test

Table 2 : Analysis of Variance table of the pre-germination treatments

Source of Variation	Sum of square	DF	MS	Fcal	Sig.
Between Group	40.458	3	13.486	6.397	.003*
Within group	42.167	20	2.108		
Total	82.625	23			

Note* significant at $p<0.05$ **NS**- not significant

Discussion

Investigation was carried out on the pre-germination treatments with different methods on *Adansoniadigitata* to enhance its early germination in preparation for plantation development and domestication. At the end of the experiment the results showed that there is significant effect across the four seed treatments and acid treated seeds had the highest number of germinated seeds No germination was observed from seeds treated with cold water and the untreated seeds. Acid treatment (H_2SO_4) was found to be effective for *A. digitata*seeds. So, acid treatment is an efficient method of increasing and accelerating seed germination of species with hard impermeable seed coat.This agreed with the work of Falemara*et al*., (2014) that acid scarification with H_2SO_4 for 1hr gave the best result and should be used in breaking dormancy of *A. digitata*seeds.Seeds that were treated with hot water gave a poor germination percentage. This implied that hot water treatment is a less efficient technique for pre-germination treatment of the seeds of *A.digitata* (Amusa, 2011; Falemara*et al.,* 2014). This is also in agreement with (Zara *et al.,* 2019) who observed that 80% of acid concentration produced an excellent germination of *Balanities eagyptica*which made the seeds to germinate within a week. The emergence of seeds of *A. digitata*from these findings agreed with the works of Ibiang*et al.* (2012) who reported on an early germination of the seed of *Tetrapteuratetraptera*with H_2SO_4scarification for six days. The germination percentage reported in this study also agreed with the works of Fasidi*et al.* (2000), who observed that treatment with concentrated H_2SO_4 significantly increased germination ($P<0.01$). Also, the results of this study supported the findings of Yildiztugay*etal*. (2008), who reported that chemical scarification (H_2SO_4) was the fastest and most effective dormancy breaking methods for *Sphaerophysaktschyana.* The result disagrees with the works of Aref (2000) who obtained good germination in *Acacia senegal* after boiling the seeds in H_2O and allowing it to cool to room temperature. Seed germination is initiated through rapid water uptake, followed by the activation of metabolic mechanisms resulted in visual signs of germination called protrusion of the radical (Quintin, 2009). Conversely, (Salami *et al.,*2019) observed the highest germination percentage (85.50%) of *Balanitieseagyptiaca* seedling from the effect of cold water. The principal factors influencing seed germination are temperature, water, oxygen and light. Temperature is the most important as it affects both the germination percentage and germination rate (Quintin, 2009).

Conclusion and Recommendations

The investigation conducted on methods of enhancing germination of *Adansoniadigitata*seed revealed that highest germination could be obtained with the use of acid treatment. However, there should be caution on the duration and volume of acid to be used for mass production of the seedlings. Acid treatment will boost the conservation of this economic species in plantation and Agroforestry system. Acid scarification is therefore recommended for the treatment of the seeds of this species for optimum germination. The role of pre-sowing treatments on seeds cannot be over-emphasized as they influence germination percentages, healthy seedlings growth as well as tree productivity.

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