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RESEARCH ARTICLE

EFFECT OF DIFFERENT PRE-TREATMENTS ON SEED GERMINATION AND WATERING REGIME ON GROWTH OF *Adansonia digitata* (Linn.) SEEDLINGS

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ABSTRACT

The As a result of high level of exploitation, seed dormancy as well as the scarcity of its wildings *Adansonia digitata* is facing a high level of endangerment. The study is set to examine the responses of *Adansonia digitata* L. seeds to varying pre-treatment methods and watering regimes in the nursery. The pre-treatments were control (untreated) (T1), fire treatment (T2), 60% sulphuric acid treatment (T3), 80% sulphuric acid treatment (T4), hot water treatment (T5), soaking in tepid water for 72 hours (T6), while watering regimes included: watering daily (W1), watering twice a week (W2) and watering once a week (W3). The experiment was laid out in a Randomized Complete Block Design (RCBD) with 5 treatments and 4 replicates for germination study and three treatments and three replicates for watering regime study. Data was subjected to descriptive statistics of frequencies and percentages, one way analysis of variance (ANOVA) and means separated by Duncan's multiple Range test at 0.05 level of significance. Germination commenced on the 9th day after sowing for T1, T3; 10th day for T4, 14th day for T5 and 44 days for T6. Germination trend was erratic, extending over long period and seedlings exhibited heteroblasticity. Seeds soaked in 80% H_2SO_4effected highest germination percentage of 73.3 and seeds soaked in hot water, 63.3, 60% H_2SO_4 had 61.6, fire treatment 48.3, tepid water treatment 38.3 and control (untreated seeds) (33.3%). W1 supported the best growth of seedlings for height, collar girth, and number of leaves. It is recommended that 80% H_2SO_4 (T4) and hot water treatment (T5) should be adopted for breaking the dormancy of *Adansonia digitata* seeds, the latter for resource poor and the former for commercial growers. Seedlings roots are tuberous, an indication of the plant's ability to store water and survive under water stress.

INTRODUCTION

Seed is crucial to regeneration. Nwoboshi (1982) indicated that seed is a key element in plant production that it exercises a very great influence on the success and failure of both natural and artificial regeneration. The quantity, physical and physiological characteristics of seeds are relevant in the production of seedlings. These characteristics result from the inherent genetic makeup of the species as well as factors induced by the harvesting, seed extraction, processing and storage. In order to produce seedlings, seeds have to germinate. The process by which the dormant embryo in the seed gets activated, grows out of the seed coat and establishes itself as a seedling is known as germination, Oboho (2014). Viable seed, water, appropriate temperature and oxygen are important for germination to take place. Sometimes, a viable seed may not germinate even when the other germination conditions exist.

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Such a seed is said to be dormant or in a state of low physiological activity. Many tropical trees have seeds of varying degrees of dormancy which must be removed by using suitable pre-germination treatments. Pre-germination treatment is the act of subjecting seeds to external conditions aimed at removing seed dormancy and enhancing seed germination within the shortest possible time (Onyekwelu and Akindele, 2002). That means that pre-treatment encourages fast and uniform germination. In order to sustainably meet the demands of the society for fruit, timber and other products, seeds of plant need to be examined on how fast they can germinate under different pre-treatment methods in the nursery in preparation for large scale plantation establishment, Oboho and Nwaihu (2016). Apart from the seed factor, moisture is critical to seed germination. It also controls various plant processes that culminate in growth and without good growth, a plant may not be able to adequately and sustainably provide man with the various forest products. The Nigerian forests has a variety of plants of great benefits to the populace; most of which are still being harvested from the wild. One of the such important plant is *Adansonia digitata.* Poor seed germination

and damage to emerging seedlings by livestock which readily eats the young trees are mentioned as the main cause of regeneration problems, Danthu *et al,* (1995). Artificial regeneration would help to improve the regeneration potential of this crop in the wild and prevent extinction. Therefore appropriate silvicultural protocol needs to be evolved concerning its germination and seedling growth with a view to establishing its plantations. Tree seedlings are raised during the dry season in the tropics for planting out shortly after the onset of the following rainy season but in many places, water is a limiting factor for raising tree seedlings and hence the prudent use of water becomes imperative to ensure that the young trees are not subjected to water stress, Olajide et al 2014). This study sets to investigate appropriate seed dormancy breaking and watering needs for raising the seedlings of *Adansonia digitata*in the nursery.

Taxonomic notes on *Adansonia digitata*

*Adansonia digitata*commonly known as *Baobab*belongs to the family *Malvaceae*(formerly Bombacaceae).It is distributed through West, Central and East Africa and its habitat is the savannah. The baobab is a deciduous trees that grows up to 20m. It has a stout trunk which tapers abruptly and the bark is grayish. The leaves are compound digitata with 5-7 leaflets (Oboho, 2014). The pentamerous flowers are white, large and hang from stalks on pedicels up to 90cm long.

Plate 1a. Kapok of *Adanasoniadigitata* exposing pulp on seeds

Plate 1b. Seeds of *Adanasoniadigitata*

Flowering normally takes place between May and July in Nigeria and bats assistitspollination. The fruit (Kapok) is an ovoid capsule with woody envelope containing pulp and seeds (Plate 1a). The seeds are kidney shaped, hard and dark brown to black in colour (Plate 1b). There are about 80 seeds embedded in the dry acid pulp of the fruit and between 1748-1760 seeds per kilogramme. Regeneration is by seed, wildlings, seedling and coppice shoots. Naturally acid treated seeds in animal stomach germinate even with slight moisture (Ahmed, 1986). Seeds require pre-germination treatment. Generally, baobab is mainly used for food. The fruits, flowers, leaves, shoots, roots of seedlings and even trees roots are edible. The leaves can be either fresh as cooked vegetable or dried powdered as functional ingredient (thickener) of soups and sauces (Bosch et al, 2004). The fruit pulp can be ground to make a refreshing drink. In general, seeds are used as a thickening agent in soups but they can ferment and used as a flavouring agent or roasted and eaten as snacks, Addy and Eteshola (1984). When roasted they are sometimes used as substitute for coffee. Powdered leaves are used as anti-ihistamine. They are variously used to treat fatigue, as a tonic and for insect bites, guinea worm and internal pains and to treat dysentery (Kings, 2002).The decoction of bark is used as substitute for quinine in cases of fever. The fibre from the inner bark is strong and widely used for making rope, basket, net, fishing line as well as for weaving. Seed oil is used for inflamed gum and to ease teeth pain. The plant is an important multipurpose tree of the savanna.

MATERIALS AND METHODS

Study site

The study was carried out in Department of Forest Resources and Wildlife Management nursery (Latitude $06^{0}24^{1}56^{11}$N and longitude $05^{0}37^{1}25^{11}$E), University of Benin, Benin City, Edo State, Nigeria. University of Benin is within the moist rain forest zone of Southern Nigeria. Its mean annual temperature ranges between 27^{0}C and 32^{0}C for most of the year. The mean relative humidity ranges from about 75% at noon to over 95% at dawn (UNIBEN Master Plan 1993) while mean annual rainfall varies between 1500-200mm.

Experimental Procedure

This study was in two phases: Germination; Watering regime and growth response.

The fruits (capsule/kapok) were harvested from good phenotype mother tree from Zaria, Kaduna state, Nigeria. They were depulped seeds extracted and air dried for 3days. Viability test was carried out for the seeds using the floatation method. 360 poly-pots filled with garden top soil were used to raise the seedlings (one seed per pot). For the germination studies carried out in the nursery, the seeds were subjected to six pre-germination treatments namely:

T_1 – Control (untreated seeds)
T_2 – Burning under dry grass (for 5 minutes)
T_3 – 60% sulphuric acid for ten minutes
T_4 – 80% sulphuric acid treatment for ten minutes
T_5 – Hot water treatment (T5)
T_6 – Soaking in tepid water for 72 hours)

Each treatment had sixty (60) seeds, making 360 seeds in all. Germination parameters investigated included date of emergence, peak germination, period of germination and germination percentage.

Watering regime and growth response

Growth study involved the use of the germinated seedlings and conducted in the screen house. Watering regimes were daily watering (W1) twice a week (W2) and watering once a week (W3). 90 seedlings were subjected to growth study, of which 48 seedlings were tagged for measurement, making 16 seedlings per watering regime (4 seedlings per replicate). The growth parameters investigated were:

- **Shoot height:** This is the distance from the seedling collar to the tip of the apical bud and this was done using a meter rule.
- **Number of leaves:** Counting of the leaves of each plant for each regime.
- **Collar girth:** Measured using a digital vernier caliper.
- **Fresh weight:** At termination of study, this was assessed by carefully uprooting five (5) seedlings under each watering regime and weighed using a weighing balance graduated in grams.
- **Dry biomass:** The five (5) selected seedlings from each watering regime investigated were oven-dried for 18 hours at 80^0 until the attainment of constant weight.

Experimental Design and Statistical Analysis

The experiment was in a Randomised Complete Block Design (RCBD) manner. For the pre-sowing treatment, there were six treatments and four replications, while the watering regime study had three treatments and four replicates. Data collected were subjected to descriptive statistics and analysis of variance (ANOVA). The means of the significantly different parameters were separated using Duncan's multiple range test at 5% level of probability.

RESULTS

Germination

Adansonia digitata exhibited hypogeal germination and the trend was erratic. Initial leaves were simple, and compound leaves started appearing from the 7^{th} week after germination. This means that A. digitata exhibited heteroblasticity (Plate 2a-b). Germination commenced within two (2) weeks irrespective of the treatment continuing throughout the period of study. At the end of study the remaining seeds in the polythene pots were still in viable state and germinating. Germination percentages recorded were 73.3, 63.3, 61.6, 48.3, 38.3, and 33.3 for T_4, T_5, T_3, T_2, T_6 and T_1 respectively. Germination commenced for T_1, T_3, and T_4 and two weeks after sowing; T_2, three weeks after sowing; T_5 three weeks after sowing and T_6 seven weeks after sowing. The peak germination for T_5 was observed at 6^{th}-7^{th} week; for T_6 at 8^{th} week; T_4 at 7^{th} week; T_3 at 8^{th} week, T_2 at 5^{th} week and T_1 at 9^{th} week. Some treatments had more than one peak. The Bulk of the germination was recorded between 5-8^{th} week and 13-17^{th} week (Fig.1). Values for the germination parameters are as shown on Table 1.

Plate 2a. Simple leaves of seedling

Plate 2b. Compound leaves of seedling

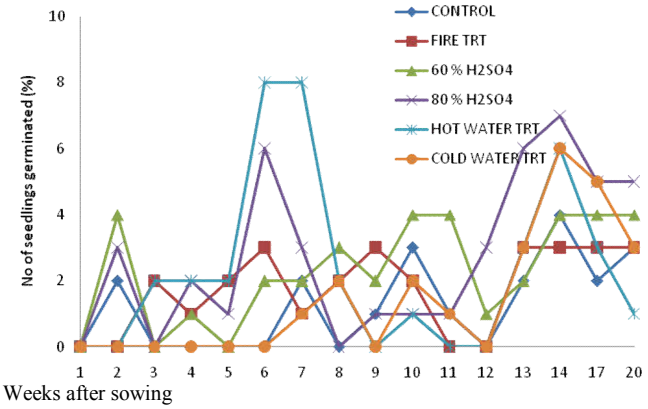

Figure 1. Weekly trend of germination in relation to treatments of *Adansonia digitata* seed

Table 1. Germination parameters values for *Adansonia digitata*

Pre-sowing treatment	Weeks to Emergence	Germination %	Germination period
T_1	2	33.3	>20 weeks
T_2	3	48.3	>20 weeks
T_3	2	61.6	>20 weeks
T_4	2	73.3	>20 weeks
T_5	3	63.3	>20 weeks
T_6	7	38.3	>20 weeks

Watering regime and growth

At termination of growth study the mean seedling height growth for the watering regimes were 36.28cm (W1), 28.56cm (W2) and 27.56cm (W3). Plant height was significantly different between the watering regimes. However, values of W2 and W3 were not statistically different (Table 2). Average weekly height growth was 3.63cm (W1), 2.85cm (W2) and 2.76cm (W3). There was great disparity in height between W1, and W2 and W3 values for the observed growth parameters.

Table 2. Growth parameter values for *Adansonia digitata*

Watering regime	Plant height cm	Collar girth mm	Number of leaves	Fresh weight (gm)	Dry weight (gm)
W_1	36.28^a	7.63^a	19.70^a	164.7^a	80.75
W_2	28.56^b	6.27^b	19.65^a	114^b	38.15^b
W_3	27.56^b	6.23^b	17.34^b	110.9^b	35.15^b
LSD	4.60	0.03	0.63	2.6	2.5^b

* Means with different alphabets along the column are statistically different.

Mean collar girth of seedlings was 7.63mm (W_1), 6.27mm (W_2), and 6.23mm (W_3). There was significant difference in the collar girth between the three different watering regimes. Values of W_2 and W_3 were however not significantly different. Average weekly increment of stem collar diameter was 0.763mm (W_1) 0.627 (W_2)mm and 0.623mm (W_3). The mean number of leaves for the watering regimes were 19.7 (W_1), 19.65 (W_2) and 17.34 (W_3). There was significant difference between values but those of W_1 and W_2were statistically similar. The mean fresh weight of the five seedlings were 164.7g for (W_1) 114g for (W_2), and 110.9g for (W_3) with values of the root component much higher than shoot. Values were significantly different between watering regimes. Seedling roots were tuberous (Plate 3). The dry weight was 80.75 (W_1), 38.15 (W_2) and 35.15gm (W_3). There was significant difference in the values but those of W_2 and W_3 were statistically similar.

Plate 3. Tuberous roots of *Adansonia digitata* seedlings in relation to watering regime (W1, W2, W3)

DISCUSSION

The germination trend of *Adansonia digitata*was erratic and period very long. For example, it started within two weeks after sowing, there followed very random germinations over the duration of study irrespective of treatment and even at the termination of study, many seeds were still germinating and others in viable status in the poly pots. Hence, Ahmed (1986) indicated that the germination period was extremely variable, between 3 weeks to 6 months. That the best germination was T4 (80% sulphuric acid) could be due to the effective wearing away of the seed coat by the acid, thus exposing the seed to factors promoting germination. Somade *et al.,* (1990) similarly found that acid scarification improved the germination of *Adansonia digitata* seeds. Sulphuric acid is thought to disrupt the seed coat of seeds and expose the lumens of macroscleried cells permitting imbibition of water which triggers germination (Amusa, 2011). The higher concentration of acid (T4) gave better germination than that of (T3) means that for this species, the higher the acid concentration, the more effective the impact. Danthu *et al.,* (1995) were of the view that *Adansonia digitata* seeds require pretreatment and that concH_2SO_4 may lead to a germination of more than 90%. Boiled water treatment (T5) also gave a high percentage germination; an indication that the treatment was also able to weaken the seed coat, promote imbibition and stimulate germination process. Saikou *et al.,* (2008) similarily found that *Acacia senegal* seeds in hot water for 10 mins increased its growth potential and opined that hot water seed treatment has the beneficial effects on pruning seeds, resulting in faster germination than untreated seeds. The ability of soaking in water to weaken seed coat is also supported by the fact that soaking in tepid water in this study gave a relatively higher germination than the untreated seeds.

In this study, untreated seeds germinated early probably because the rainy season had commenced and was able to moisten the soil in poly-pots, soften the seed coat and break dormancy. Hence Ahmed (1986) stated that seeds of *Adansonia digitata* are thought to germinate only in exceptionally good rainy season in the wild. Also Ibrahim and Otegbeye (2004) opined that soaking *Adansonia digitata* seeds for 1,12 and 24 hours resulted in increasing rate of germination. That few untreated seeds germinated early indicates that seeds of *Adansonia digitata* from the same kapok could have different seed coat hardness and micropyle size. This could be a subject for further investigation. Seedlings of *Adansonia digitata* are heteroblastic. This situation is also found in *Canarium schweinfurthii*. The daily watering regime (W1) gave the best growth performance for *Adansonia digitata* seedlings for plant height, collar girth, number of leaves, fresh and dry weight as well as root size. This is in agreement with Ikojo et al (2005) who reported that watering enhances growth of *Brachystegia eurycoma*. The growth parameters for the W2 and W3 watering regimes were however lower than values of W1 but they were not statistically different from each other also they did not predispose the crop to any growth disadvantage. This is probably the results of the tuberous nature of the seedling root (Plate 3). This adaptation is a xerophytic tendency which aids this species in its ability to store water in the root and tide over water stress situations. Vandoome *et al.,* (2012) indicated that water stress drastically decreases fresh and dry weight, leaf number, total leaf area and stomata conductance. Similarly, Sadeghian and Yavari (2004) were of the opinion that seedling growth severely diminished with increased drought stress irrespective of the genetic differences in sugar beet. And Sharma and Prasad (1984) indicated that inadequate soil moisture can reduce germination, slow down seedling growth and decrease yield in rainfed crops.

Conclusion

Adansonia digitata exhibits hypogeal type of germination, pattern of germination is erratic and period of germination

very long. The seedlings are heteroblastic. The germination percentages obtained from the various pre-sowing treatments were 73% (80%, H2SO4), 63% (hot water treatment, 61% (60% H2SO4), 48% (burning) and 38% soaking in tepid water) and 33% (untreated seeds). The highest watering regime (W1) gave the best growth performance on the seedlings. The lower levels of watering regime (W2 and W3) gave lower growth parameter values but was not detrimental to growth. The seedlings had tuberous roots, an advantage for water storage and xerophytic tendency, exhibited by the seedlings of *Adansonia digitate* early in life. It is recommended that concentrated sulphuric acid be used to pretreat its seeds for large scale seedling production while soaking in boiled water until it cools could be used for small quantities needed by rural farmers. Daily watering regime promoted the best level of seedling growth but other levels (once a week and twice a week watering) did not put the seedlings to any growth disadvantage.

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