Original Research Article

Propagation of *Treculia africana* as Influenced by Seed Storage and Propagation Media

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Abstract

Treculia africana is an economically important but often neglected tropical fruit tree native to many tropical countries. The main objective of this study was to evaluate the seedling emergence and seedling quality of *Treculia africana* seeds as influenced by storage duration and propagation media. Storage duration influenced percentage seedling emergence and seedling growth. Generally, no germination was recorded in the seeds stored beyond two weeks, irrespective of the propagation media used. There was a highly significant ($P < 0.01$) storage duration × propagation media interaction on all parameters measured. The highest germination percentage (87.5%) was recorded by freshly collected seeds sown in both medium sand and fine sand. A consistently higher plant height, number of leaves and leaf area was recorded in fresh seeds sown in medium sand. The effect of media was not significant. The study suggests that seed storage had a deleterious effect on the germination of the species, thus implying that storing the seeds of *T. africana* beyond two weeks could impede viability and recommends that *T. africana* seeds should be sown immediately the fruits are harvested preferably in medium sand.

Key words: *Treculia africana*, seed storage, seed viability, propagation media, seedling growth.

INTRODUCTION

Treculia africana Decne (African bread fruit; wild jack fruit, or African boxwood), is a neglected and underexploited tropical tree crop native to many tropical countries like Ghana, Sierra Leone, Nigeria and The West Indies. It is commonly called "afon" and "ukwa" by the Yoruba and Igbos of Nigeria. The seed is a popular traditional food item, commonly roasted, cooked, mashed and consumed either directly as snack food or as flour for use in soup thickening, cakes, and bread and for food formulations (Ariahu et al., 1999; Fasasi et al., 2003; Osuji and Owei, 2010). Various authors have reported that *T. africana* seeds are highly nutritious and constitute a cheap source of vitamins, minerals, proteins, carbohydrate and fats (Giami et al., 2002; Adindu and Williams, 2003; Fasasi et al., 2003). According to Onyekwelu and Fayose (2007), fresh *T. africana* seeds have carbohydrate, crude protein, moisture, crude fibre, ash and ether extract (fat) contents of 38.26, 17.67, 3.82, 15.85, 3.97 and 15.85%, respectively. The proximate and mineral composition of *T. africana* seed hull meal showed that it is a good source of minerals especially iron (Akubor et al., 2000) that is required for formation of haemoglobin in animals for resistance of foreign bodies as well as active function of the animals (Ejidike and Ajileye, 2007).

In Nigeria and Cameroon many rural dwellers are engaged in collection, processing and sale of *T. africana* seeds as a means of livelihood. Due to its domestic and economic importance, the tree has been heavily exploited resulting in its current highly endangered status (Onyekwelu and Fayose, 2007). To abate total loss or extinction of some of these important forest species, they must be cultivated more intensely through improved propagation either by seed or stem cuttings. Limited agronomic information and lack of mechanical devices for large scale processing and storage of the fruit and seed have limited the widespread utilization and cultivation of the African breadfruit (Osuji and Owei, 2010). The seeded breadfruit is always grown from seeds, which must be planted when fairly fresh as they lose viability in a few weeks. Propagation from seed is inexpensive and usually effective, and is therefore a viable method for their ex-situ conservation (Abirami et al., 2010). Obviously, an understanding of seed physiology could expectedly contribute to the effort of seed-based in-situ conservation as well as ex-situ cultivation (Sharma and Sharma, 2006). The proper handling of seed through the processes of ripening or maturation, collecting, processing, storage (if needed), dormancy, stratification and germination is required for success in producing a new seedling. Two main factors that affect seed quality are seed harvest time and seed extraction method (Demir and Samit, 2001). The seeds of the African breadfruit with fleshy fruits are enclosed with soft pulp that can decay and cause injury (Schopmeyers, 1974; Keay, 1989). The fleshy tissues or pulp should be removed to prevent damage to the embryo from spontaneous heating or an inhibiting substance (MacDonald, 1986). Often, seed ripening and collection does not correspond with the time of seedling production, while some species do not produce seeds all year round. Seed storage is therefore vital to secure the supply of good quality and quantity seeds for planting

programme (Siddique and Wright, 2003; Onyekwelu and Fayose, 2007).

Also of importance is the nursery potting media which greatly influences the quality of seedlings produced thereof (Baiyeri, 2005; Sahin et al., 2005; Agbo and Omaliko, 2006) and consequently, the quality of seedling obtained from a nursery influences re-establishment in the field (Baiyeri and Mbah, 2006a) and the eventual productivity of an orchard (Baiyeri and Ndubizu, 1994). Germination and seedling growth response of different plant species to different propagation media varies. Baiyeri and Mbah (2006a) found that seedlings of *T. africana* did better when raised in poultry manure ammended sawdust based media than in soil based media. While Medagoda and Weerawardana (2005) reported that media did not significantly influence the germination of *Macadamia* seeds, Ugese (2010) found that growth media significantly influenced seedling emergence of *Tamarindus indica*. Olubosipe et al. (1988) obtained a significantly higher germination of *T. africana* seeds when sown in river sand. This study was carried out to investigate the effect of seed storage and propagation media on the germinability and seedling growth of *T. africana*.

MATERIALS AND METHODS

The experiment was carried out at the Delta State University, Asaba Campus (06º14´N and 06º49´E) in Oshimili South Local Government Area of Delta State, Nigeria. Asaba lies in the tropical rainforest zone with annual rainfall range of 1 500 mm to 1 849.3 mm. Mean temperature are 23.3 ºC with a maximum of 37.3 ºC. Mean monthly soil temperature at 100 cm depth and sunshine is 28.3 ºC and 4.8 hours, respectively (Nigeria Meteorological Center 2003).

Ten fruits of *Treculia africana* were procured from fruit collectors at Ahiazu, in Owerri Imo State, Nigeria. The fruits were depulped and air dried in a dark condition for 0, 1, 2, and 3 weeks (0W, 1W, 2W, and 3W), respectively. Four planting media consisting of fine sand (FS), medium sand (MS), coarse sand (CS), and sawdust (SD) were filled into 45 cm × 45 cm × 30 cm germination boxes. The particle size for FS, MS and CS were 0.1 - 0.25 mm, 0.25 - 0.5 mm and 0.5 - 1.0 mm, respectively. The particle size diameter was established based on the United States Department of Agriculture (USDA) particle size classification. The sand was obtained from a nearby River Niger dumpsite, while the composted sawdust was from Asaba wood village sawmills. All media except sawdust were sieved, and cleaned prior to use. Forty seeds from each seed lots were randomly sown in the different media in a completely randomized design in a split plot layout with soil media as the main plot and seed storage duration as the sub plot. Each treatment was replicated four times with daily watering to field capacity. The parameters assessed weekly included germination percentage, plant height, leaf number, and leaf area for 6 weeks. Plant height was measured with a meter rule while leaf area was determined using a LI-COR 3000C portable leaf area meter. The seed germination criterion was visible protrusion on the soil surface of at least 0.5 cm of the cotyledon and hypocotyls of the seedlings. Data collected were subjected to analysis of variance (ANOVA) at 5% level of probability and significant means were separated by standard error using Genstat 3 Discovery edition (Genstat 2007).

RESULTS

Germination of seeds under the various storage and media treatments started 9 days after sowing and continued till the 27th day. The percentage seedling emergence was influenced by seed storage duration. Germination was consistently higher in 0W while the seeds stored for 3 weeks (3W) failed to germinate. At 2WAS (Weeks after sowing) the result showed a progressive reduction in seedling germination percentage with increase in duration of storage with 15.6% in 0W and 4.7% in 1W while 2W and 3W recorded no germination. This trend was maintained till the final assessment at 5WAS with 0W recording

Table 1. Effect of seed storage duration on germination percentage

Seed storage duration	Weeks after sowing				
(Weeks)	1	2	3	4	5
0W	0.0	15.6	64.1	78.1	78.1
1W	0.0	4.7	39.1	56.2	56.2
2W	0.0	0.0	4.7	10.9	10.9
3W	0.0	0.0	0.0	0.0	0.0
SEM	ns	3.4**	5.6*	4.6*	4.6*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively
ns: not significant

Table 2. Effect of seed storage duration on height (cm)

Seed storage duration	Weeks after sowing					
(Weeks)	1	2	3	4	5	6
0W	0.0	0.54	2.16	8.12	11.06	12.16
1W	0.0	0.11	0.74	3.27	9.7	10.91
2W	0.0	0.0	0.24	0.71	2.06	2.54
3W	0.0	0.0	0.0	0.0	0.0	0.0
SEM	ns	0.1**	0.4*	0.8*	0.5*	0.8*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively
ns: not significant

Table 3. Effect of seed storage duration on the number of leaves

Seed storage duration (Weeks)	Weeks after sowing 1	2	3	4	5	6
0W	0.0	1.75	4.81	9.12	11.12	13.25
1W	0.0	0.31	1.75	5.12	6.25	8.50
2W	0.0	0.0	0.56	1.00	1.19	2.0
3W	0.0	0.0	0.0	0.0	0.0	0.0
SEM	ns	0.3*	0.4*	0.6*	0.7*	0.8*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively
ns: not significant

a higher germination than 1W and 2W while 1W was also higher than 2W (Table 1). Plant height was influenced by seed storage duration. Plant height was consistently higher in 0W and lowest in 2W (Table 2). Similarly, the number of leaves produced was higher in 0W than the rest of the treatments. There was a trend of consistently higher number of leaves in 0W from 2WAS to 6WAS (Table 3). Leaf area was influenced by seed storage duration. A trend of consistently higher leaf area was also observed in 0W when compared to the rest of the treatments (Table 4).

Propagation media did not influence the germination of the species. Likewise, no pronounced influence of media was observed among the different treatments with regards to seedling height, number of leaves and leaf area.

Table 4. Effect of seed storage duration on leaf area (cm^2)

Seed storage duration (Weeks)	Weeks after sowing 1	2	3	4	5	6
0W	0.0	0.36	2.07	3.35	3.87	4.1
1W	0.0	0.06	0.36	2.08	3.45	3.38
2W	0.0	0.0	0.15	0.4	0.69	0.9
3W	0.0	0.0	0.0	0.0	0.0	0.0
SEM	ns	0.1*	0.2*	1.1*	0.2*	0.2*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively
ns: not significant

A significant seed storage duration × media interaction was observed with seedling emergence and seedling growth performance. Generally, no germination was recorded in the seeds stored beyond 2W irrespective of the media used. Seedling emergence was influenced by seed storage duration × media at 2WAS with the highest seedling emergence occurring in 0W × ms, 0W × SD, 0W × CS and 1W × FS. At 3WAS, the highest seedling emergence was recorded in 0W × SD while the least was in 1W × MS. Maximum seedling emergence was obtained in 4WAS with 0W×MS and 0W × FS recording highest germination

Table 5. Effect of seed storage duration and propagation media on germination percentage

Seed storage duration (Weeks) / Propagation media	Weeks after sowing 1	2	3	4	5
3WFS	0.0	0.0	0.0	0.0	0.0
3WMS	0.0	0.0	0.0	0.0	0.0
3WCS	0.0	0.0	0.0	0.0	0.0
3WSD	0.0	0.0	0.0	0.0	0.0
2WFS	0.0	0.0	18.75	18.75	18.75
2WMS	0.0	0.0	0.0	0.0	0.0
2WCS	0.0	0.0	0.0	18.75	18.75
2WSD	0.0	0.0	0.0	6.25	6.25
1WFS	0.0	12.50	43.75	50.0	50.0
1WMS	0.0	0.0	18.75	62.50	62.50
1WCS	0.0	0.0	31.25	43.75	43.75
1WSD	0.0	6.25	62.50	68.75	68.75
0WFS	0.0	0.0	62.50	87.50	87.5
0WMS	0.0	25.0	62.50	87.50	87.5
0WCS	0.0	12.50	56.25	68.75	68.75
0WSD	0.0	25.0	75.0	68.75	68.75
SEM	0.0	2.4**	4.8**	5.7***	5.3**

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively, ns: not significant

percentage (87.5%), followed by 0W × SD, 0W × CS and 1W × SD (68.8%), while the lowest percentage seedling emergence (where the seedlings sprouted) was recorded in 2W × SD (6.25%) (Table 5).

Table 6. Effect of seed storage duration and propagation media on plant height (cm)

Seed storage duration (Weeks) / Propagation media	Weeks after sowing 1	2	3	4	5	6
3WFS	0.0	0.0	0.0	0.0	0.0	0.0
3WMS	0.0	0.0	0.0	0.0	0.0	0.0
3WCS	0.0	0.0	0.0	0.0	0.0	0.0
3WSD	0.0	0.0	0.0	0.0	0.0	0.0
2WFS	0.0	0.0	0.98	1.70	2.68	3.03
2WMS	0.0	0.0	0.0	0.0	0.0	0.0
2WCS	0.0	0.0	0.0	0.78	3.23	3.88
2WSD	0.0	0.0	0.0	0.35	2.33	3.23
1WFS	0.0	0.20	1.50	2.55	10.90	12.05
1WMS	0.0	0.0	0.28	2.48	10.13	11.70
1WCS	0.0	0.0	0.69	3.83	7.93	8.63
1WSD	0.0	0.25	0.48	7.75	9.83	11.28
0WFS	0.0	0.0	0.48	7.85	11.63	13.10
0WMS	0.0	0.88	1.55	9.10	11.73	14.48
0WCS	0.0	0.35	3.45	8.55	11.38	12.10
0WSD	0.0	0.91	3.15	7.00	9.50	9.95
SEM	0.0	0.10**	0.83*	0.9*	0.9*	1.1*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively, ns: not significant

Table 7. Effect of seed storage duration and propagation media on the number of leaves

Seed storage duration (Weeks)	Weeks after sowing					
Propagation media	**1**	**2**	**3**	**4**	**5**	**6**
3WFS	0.0	0.0	0.0	0.0	0.0	0.0
3WMS	0.0	0.0	0.0	0.0	0.0	0.0
3WCS	0.0	0.0	0.0	0.0	0.0	0.0
3WSD	0.0	0.0	0.0	0.0	0.0	0.0
2WFS	0.0	0.0	0.98	1.7	2.68	3.03
2WMS	0.0	0.0	0.0	0.0	0.0	0.0
2WCS	0.0	0.0	0.0	0.78	3.23	3.88
2WSD	0.0	0.0	0.0	0.35	2.33	3.23
1WFS	0.0	0.2	1.50	2.55	10.9	12.05
1WMS	0.0	0.0	0.28	2.48	10.13	11.7
1WCS	0.0	0.0	0.69	3.83	7.93	8.63
1WSD	0.0	0.25	0.48	7.75	9.88	11.28
0WFS	0.0	0.0	0.48	7.85	11.63	13.10
0WMS	0.0	0.88	1.55	9.1	11.73	14.48
0WCS	0.0	0.35	3.45	8.55	11.38	12.1
0WSD	0.0	0.91	3.15	7.0	9.50	8.95
SEM	0.0	0.1**	0.81**	0.9*	0.9*	1.1*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively, ns: not significant

Table 8. Effect of seed storage duration and propagation media on leaf area (cm^2)

Seed storage duration (Weeks)	Weeks after sowing					
Propagation media	**1**	**2**	**3**	**4**	**5**	**6**
3WFS	0.0	0.0	0.0	0.0	0.0	0.0
3WMS	0.0	0.0	0.0	0.0	0.0	0.0
3WCS	0.0	0.0	0.0	0.0	0.0	0.0
3WSD	0.0	0.0	0.0	0.0	0.0	0.0
2WFS	0.0	0.0	0.6	1.08	1.13	1.15
2WMS	0.0	0.0	0.0	0.0	0.0	0.0
2WCS	0.0	0.0	0.0	0.33	0.88	1.28
2WSD	0.0	0.0	0.0	0.2	0.75	1.18
1WFS	0.0	0.08	0.83	1.25	3.73	4.35
1WMS	0.0	0.0	0.13	1.4	3.75	4.13
1WCS	0.0	0.0	0.2	1.85	2.73	3.1
1WSD	0.0	0.16	0.29	3.83	3.56	4.35
0WFS	0.0	0.6	0.95	3.68	3.68	4.16
0WMS	0.0	0.0	2.65	2.7	4.28	4.25
0WCS	0.0	0.3	2.25	3.99	3.08	3.35
0WSD	0.0	0.53	2.43	3.03	4.28	4.63
SEM	0.0	0.1*	0.5*	0.7*	0.7*	0.9*

SEM standard error of the mean, *, **, *** for $P < 0.01$, 0.02 and 0.05 levels, respectively, ns: not significant

Plant height was significantly higher consistently in 0W × MS and 0W × FS. At 2WAS, 0W × SD recorded higher plant height. At 3WAS, 0W × SD and 0W × CS had higher height than the rest of the treatments and thereafter an improved plant height was recorded in 0W × MS and 0W × FS (Table 6). Similarly, there was a significant seed storage duration × propagation media interaction effect on the number of leaves produced. 0W × SD and 0W × MS had higher number of leaves than 0W×CS which in turn was higher than the rest of the treatments at 2WAS. At 4 and 5WAS, a higher number of leaves was recorded in 0W × MS and 0W × MS than 0W × FS which in turn recorded higher values than the rest of the treatments. At 6WAS, 0W × MS had significantly higher number of leaves than the rest of the treatments (Table 7). There was a highly significant effect of seed storage duration × media interaction on leaf area. The trend displayed was similar to that obtained in the number of leaves produced. The results showed that 0W × SD and 0W × MS consistently did better than the rest of the treatments. At 6WAS, 0W × SD, 0W × MS, 0W × FS, 1W × SD, 1W × MS and 1W × FS had higher leaf area than the rest, although not different from 0WCS and 1WCS which in turn did better than the rest of the treatments (Table 8).

DISCUSSION

The results from this study indicated that seed germination and seedling performance of *T. africana* was influenced by seed storage duration and the combined effects of storage duration and propagation media. A deleterious effect of seed storage on the germination of the species was recorded, thus implying that storing the seeds of *T. africana* beyond two weeks could impede viability. The decreased seedling emergence recorded agrees with the findings of Onyekwelu and Fayose (2007) who reported that for storage methods that do not kill the seeds of *T. africana,* a significant and progressive decrease in germination is rather observed as storage duration increases. Although ICRAF (2009) described *T. africana* seeds storage behaviour as orthodox, the result from this experiment and that of Onyekwelu and Fayose (2007) has shown that the seeds cannot store dried or are not amenable to storage for a long period of time without germination being impaired. Long term storage is known to decrease the germination ability and sprouting of seeds (Baskin and Baskin, 1998) as a result of oxidative stress and related deteriorative events (Bailly, 2004). Kings and Roberts (1979) earlier reported that when freshly harvested seeds are dried, viability is at first slightly reduced as moisture is lost and if drying continues further, viability is eventually reduced to zero in the group of recalcitrant seeds. These involvements, at least in part of redox metabolic perturbation in the storage-dependent partial loss of seed viability according to Sharma and Sharma (2010) explain the results obtained from this study.

The effect of media was not pronounced on the seedling emergence and seedling quality traits. Medagoda and

Weerawardana (2007) also recorded a lack of media effect on seed germination of several members of *Macadamia* species/cultivars. This result contrasted previous studies by Baiyeri (2003) and Baiyeri and Mbah (2006a), who used soil based and soilless media and recorded relatively lower percentage seedling emergence, ascribing the poor seedling emergence to deformity and the bulk density of the potting media. Baiyeri and Mbah (2006b) ascribed the relatively low percentage seedling emergence of *T. africana* to loss of viability and stated further that the reduction in viability might probably be associated with moisture loss. The result also contrasted the findings of previous studies by Olubosipo et al. (1988), Ugese (2010) and Abirami et al. (2010). While Olubosipo et al. (1988) obtained the best seedling emergence of *T. africana* in sharp sand, Ugese (2010) reported a remarkable response of *Tamarindus indica* seedlings to growth media in terms of plant height, number of leaves and leaf length. The seedling emergence and seedling quality may not only be related to the combination of the propagation media used but also the poultry manure inclusions and the level of poultry manure inclusions.

The lack of significant effect of propagation media on the seedling emergence and seedling quality traits may be explained by Cernac et al. (2006), who confirmed that successful germination and seedling establishment rely more upon the presence of sufficient seed storage reserves and the ability to utilize them. Although Abirami et al. (2010) ascribed the enhanced germination response of nutmeg seeds in different media to the physical properties and good water holding capacity of the media, Schneider and Gupta (1985) speculated that the time to corn emergence was most sensitive to soil temperature and was successively less influenced by soil water potential and soil aggregate size. Nursery crops can germinate in virtually any non-toxic substance that provides anchorage, water, oxygen and essential elements, some materials are easier to use and manage. The physical properties such as particle size, bulk density, air space, water holding capacities and other physical properties as well as availability and cost of growing media are critical factors to be considered in selection of potting medium. Generally, mixtures of two or more materials may be used to provide the desired air space, moisture and nutrient retention and bulk density (Dolor et al., 2009).

Pending further investigation, it is concluded that seed germination and seedling performance of *T. africana* was influenced by storage duration and the combined effects of storage duration and propagation media. It is recommended that the seeds of *T. africana* be sown as soon as they are harvested using medium sand as propagation media in the nursery.

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