FULL LENGTH RESEARCH ARTICLE

STUDIES ON THE GERMINATION AND SEEDLING CHARACTERISTICS OF THE SAVANNA PALM TREES

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ABSTRACT

Mode of germination and seedling characteristics of four Savanna palm trees; *Borassus aethiopum, Hyphaene thebaica, Phoenix reclinata* and *Raphia sudanica* were studied. In the course of their germination, the radicle was found to be cotyledonary in nature, and it carried the undeveloped plumule below ground before its further development. This is called cryptogeal germination which occurred in two stages: (i) preparatory germination and (ii) germination proper. Bigger seedlings were produced by larger seeds. Pinnate and palmate leaf arrangements with parallel venation were also found among these palms.

***Keywords*:** Palm trees, germination, seedling, characteristics, Savanna, Nigeria

INTRODUCTION.

The Savanna trees are exposed to regular annual bush burning, over exploitation and deforestation to meet human needs of farming, housing and industrial development. These have led to great modification of their natural habitats hence threatening their existence (Agboola 1995). Another problem facing plants in the tropics is difficulty of regeneration, which is largely caused by seed origin, degree of ripeness, age, collection, processing, storage, germination and seedling survival (Olofinboba 1997). Furthermore, seeds of most forest tree species have been found to be dormant and therefore do not germinate readily with some of them taking several months to germinate. One hindrance is probably the hard layer commonly present in the fruit wall, which delays germination until it has softened (Werker 1980, NIFOR 1984, Tran & Cavanagh 1984, Agboola & Etejere, 1991, Bewley & Black, 1994 Jorge *et al.* 1998, F.A.O 2001).

Savanna palm trees are economically very important sources of wood, fuel and fodder, with some playing prominent roles in nutrient recycling and agro-forestry practices (Conelly & Wilson 2001).The Sap of many species, like *Hyphaene thebaica* Hutch. & Dal. 1937 and *Phoenix reclinata* Hutch. & Dal. 1937 are tapped as sources of sugar and palm wine yielding up to 1200 liters per annum. Sago, a starch prepared from the pith of *Borassus* forms part of an important human diet in America and Europe used for thickening Soups and making Puddings (Crosby 2007). Fibers from the leaves of palm trees are used as weaving materials (Etejere, *et al.* 1982, Agboola & Adedire 1985, NIFOR, 1989, Esenawo & Adebona, 1990, Conelly & Wilson 2001).

Recently, reforestation and landscaping practices in Nigeria have centered more on the regeneration of exotic and ornamental trees rather than the native ones, particularly palm trees, a situation that has increased their utilization. Since these plants have a very low population and are threatened seriously with extinction, there is the need to save the existing species in this region. This paper presents results of a study aimed at determining the mode of germination and seedling characteristics common to Savanna palm trees in Zaria, northern guinea Savanna, Nigeria with the view to understand their biology, hence boost their propagation.

MATERIALS AND METHODS

Species of palm trees studied: The Seeds of 4 indigenous Savanna Palm tree species were collected and soaked in water namely, *Borassus aethiopum, Hyphaene thebaica*, *Phoenix reclinata* and *Raphia sudanica* (Hutch. & Dal. 1937*)* thereafter the seeds were planted in a compost soil (Whitmore 1977, Opeke 1982 NIFOR 1985, & Collinbourne 2001).

Parameters measured: The height of the shoots and root length were measured immediately after germination and at later stages of development, for two weeks and for 14 months respectively. Observations were also made on the nature, and mode of germination of the Palm trees. Seedling characteristics were also observed in term of the number of foliage leaves, their forms, arrangement and venation.

RESULTS

During germination in *B. aethiopum, H. thebaica, P. reclinata and R. sudanica* the plumule pierced through the cotyledonary sheath, while the seedling remained attached to the seed. (Plates Ia, IIb, IIIc and IVb). A significant elongation of the cotyledonary sheath was observed both in *B. aethiopum* and *H. thebaica* followed by *R. sudanica* and P. *reclinata* respectively (Plates Ib, IIb, IIIc and IVd) The leaves of *B. aethiopum, H. thebaica,* and *P. reclinata* were all V-shaped while they were ∧-shaped in *R. sudanica*. The first foliage leaves were found to be simple and lanceolate in all the four species studied and succeeded by pinnately arranged leaves in *P. reclinata* and *R. sudanica.* However, the leaves were segmented, obovate and palmate in *B. aethiopum* and *H. thebaica* (Plates Ie, IIe,IIIf and IVc). Seedlings from large seeds recorded higher shoot/root ratios (Fig. 1).

B. aethiopum.

For this species, the fibrous shell of the endocarp did not rupture easily, but decayed gradually. This appeared to cause the long delay in germination for *about* 6-12 months compared to the other palms under study (Plate Ia).

The cotyledonary sheath elongated to about 12.5 cm into the soil forming a swelling towards the tip, with the radicle formed below it. Similarly, cotyledonary stalk (an edible storage organ) with a shell, about 41.4 cm long, a tap and branched roots formed and were buried to a depth of 32.3cm. Later the covering of the storage organ disintegrated and the tap root system become well established and buried to a depth of 64.6cm into the soil (Plates Ib, c, and d)

Second foliage leaf with lamina had a brownish scar at its apex while the primary leaf was deeply segmented. The tap root with

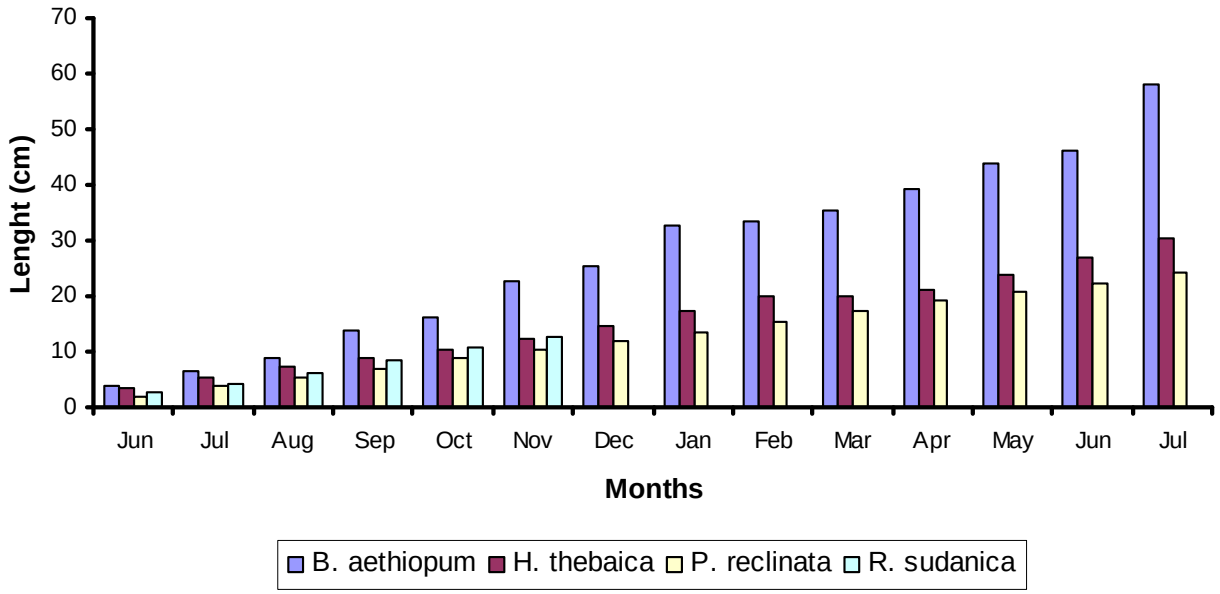


FIG. 1. VARIATIONS IN AVERAGE LENGTH OF SEEDLING SHOOT

branches and root hairs were buried to a depth of about 99.7cm into the soil. (Plate Ie). At this stage, the cotyledonary stalk reached its full width and split and the stem commenced upward growth. At 5 months after germination, cotyledonary stalk and the root were buried to a depth of 135 cm into the soil (Plate If).

H. thebaica.

The fibrous shell surrounding the endosperm ruptured within 2-3 months at the onset of the germination (Plate IIa). Elongation of the cotyledonary sheath ceased when it reached about 47cm long (Plate IIb). The young whitish stem of about 14cm long developed and commenced upward growth. Likewise, branched roots with hairs were formed at the base and as it enlarged, more leaves were formed .A brownish tap root grew to about 93cm deep (Plate IIe). Leaves became larger when the tap root extended to about 149.5 cm (Plate IIf).

P. reclinata.

The seed (stone) ruptured in about 2 months and the cotyledonary sheath extended into the soil. Branched roots developed from the radicle and buried to a depth of 11.3 cm (Plate IIIb). At this stage, third leaf with digitate lamina and pinnate arrangement became evident, and a tap root system became established to about 28.4cm (Plate IIIe). Fourth leaf emerged when the stem became established with the tap root branched with hairs became about 49.7cm (Plate IIIf).

R. sudanica.

There was poor germination in this species, which occurred in 2-4 months. The cotyledon elongated up to 24.3cm into the soil. The plumule gradually turned green and compound foliage leaves emerged piercing it. The tap and branch roots developed with hairs buried to a depth of about 28cm (Plate IV b). The stem was fully taking shape at about 2 months old with points for new leaves to emerge (Plate IVc).

DISCUSSION

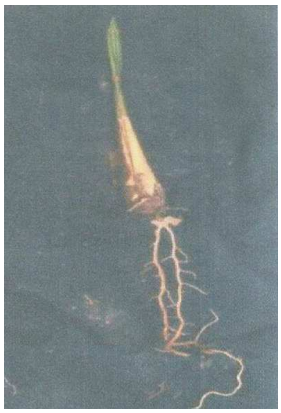
Germination in Savanna palm trees could be referred to as "Cryptogeal" because the immature plumule is carried into the soil, before its development and that of the radicle takes place. This is similar to the findings of Jackson (1968) in *Botyrospermum Paraxodum* Hutch & Dal 1937 seed. There is obvious advantage to the savanna palm seedlings in this mode of germination, because they are buried deep in the soil thereby decreasing possibilities of desiccation (Opeke 1982) enabling the seedlings to absorb leached nutrients and moisture thereby storing and conducting nutrients round their bodies (Katherine 1977).

During germination, the seedling remained attached to the seed so that food reserve is transmitted to it from the endosperm (Tomlinson 1961). It was also observed that subsequent leaves were of increasing height than the earlier ones. This was an observation earlier made by Whitmore (1977). It was observed that large seeds achieved initial increase in height without having to photosynthesize, perhaps by making use of their cotyledons to provide the resources for this, while small seeds with far less resources need to photosynthesize immediately they germinate using their cotyledons (Carl & Paul 1975, Micheal 1993). Plant breeders are advised to consider seed size during seed selection in order to obtain bigger and vigorous seedlings.

The germination of *B. aethiopum* showed gradual and slow decaying of the fibrous shell of the endocarp, which appeared to slow down germination contrary to earlier findings (Tomlinson 1961, Corner 1966 & Whitmore 1977), that the shell of the endocarp in Palms ruptured easily. Piggot (1964) observed that roots and leaves can appear 4 months after planting, but with some nuts, even on good conditions, it may take up to one year. The appearance of deeply segmented foliage leaves, splitting of cotyledonary stalk, commencement of its upward growth and palmate nature of third leaf have been observed in

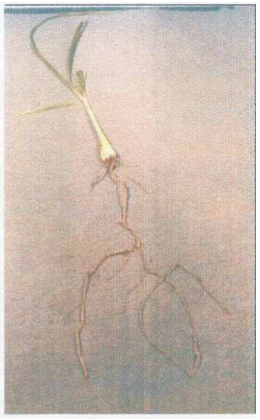
A

B



C

D



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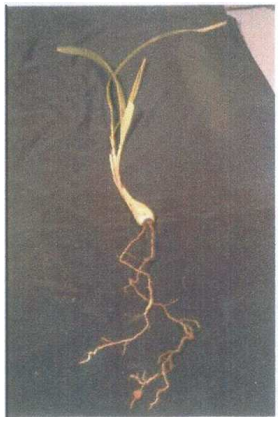
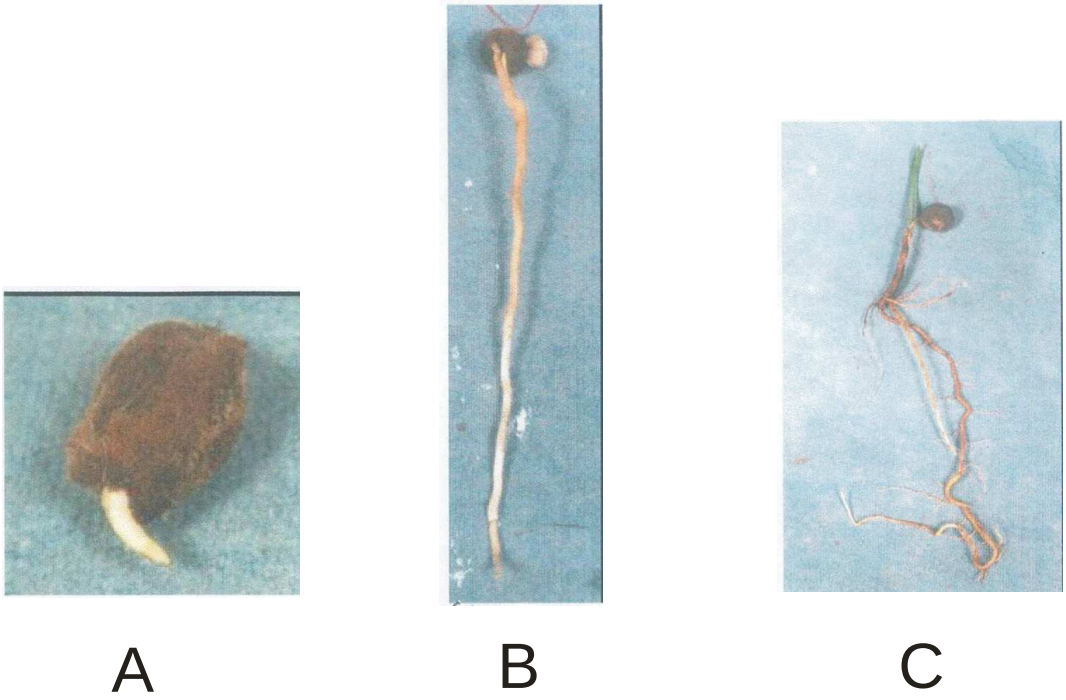


F

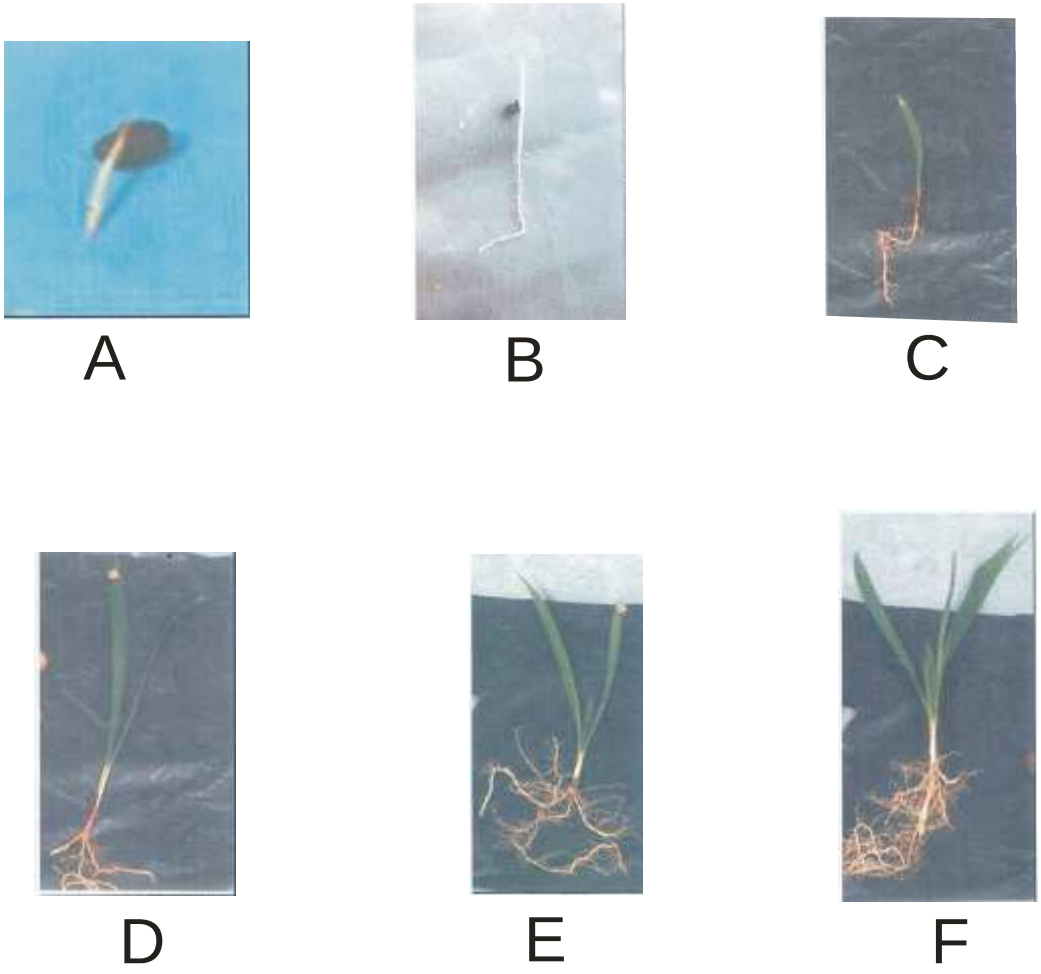
A= 8 weeks after germination
B= 12 weeks after planting
C= 54 weeks old
D= 58 weeks old
E= 62 weeks old
F= 72 weeks old

PLATE I. SHOWING THE STAGES OF GERMINATION IN *B. aethiopum*



A= 27 days after planting
B= 16 weeks after planting
C= 21 weeks old
D= 29 weeks old
E= 52 weeks old
F= 54 weeks old

PLATE II. SHOWING THE STAGES OF GERMINATION IN *H. Thebaica*



A= 2 weeks after planting
B= 10 weeks after planting
C= 15 weeks old
D= 19 weeks old
E= 22 weeks old
F= 25 weeks old

PLATE III. SHOWING THE STAGES OF GERMINATION IN *P. reclinata*

A= 5 weeks after planting
B= 7 weeks old
C= 10 weeks old

PLATE IV. SHOWING THE STAGES IN GERMINATION IN *R. Sudanica*

some Species of palm trees such as *Corrypha* and *Hyphaene,* (Tomlinson 1961).

Germination of *H. thebaica* showed the formation of branched roots with hairs and the appearance of more leaves as the seedlings enlarged (Whitmore 1977). Highest root length of 140.5 cm was recorded in this species suggesting that *H. thebaica* exhibits desert adaptive characteristics more than the other Palm species studied. The germination of *P. reclinata* showed the appearance of digitate lamina, pinnate leaf arrangement of increasing complexity as well as the establishment of a branches root system as obtained in species like *Nyphia, Lodoicea, Elaes* etc (Whitmore 1977).

In this study, germination in *R. sudanica* started with the emergence of a brownish plumule independent of the cotyledon stalk which elongated up to about 24.3 cm into the soil, contrary to Purseglove (1974), who reported that a massive stem apex is buried to a depth of up to 1 meter below the soi1. Similarly, Whitmore (1977) reported pinnate leaves arrangement in palm Species of *Roystenia, Lodoicea, cocos* etc, with initial few leaflets inserted below a simple terminal leaflet. The poor germination observed in *R. sudanica* can be attributed to its perennial and revering characteristics which make it difficult to handle in Savanna region. Therefore, production of its seedlings should be restricted to riverine land where there is sufficient water. However, the survey revealed that the four species of palms are very common and naturally grow both in Guinea and Sudan Savannas.

In conclusion, germination among the Savanna palm trees studied occurred in two stages:

(i) Preparatory germination which took place with the elongation of cotyledonary sheath pushing the shoot apex into the ground forming a swelling and a radicle.

(ii) Germination proper which commenced with the exertion of a non photosynthetic plumule in *B. aethiopum, H. thebaica* and *R. sudanica* except in *P. reclinata,* where it is photosynthetic in nature.

Due to their slow germination and growth rates, there is the need for further investigation on ways of breaking their dormancy so as to hasten their germination.

REFERENCES:

Agboola, D. A. 1995. Studies on dormancy and germination of seeds of *Peropsis africana.* Nigerian Journal of Botany. 8:47 - 55

Agboola, D. A & Adedire, M.O 1985. Responses of treated dormant seeds of three tropical tree species to germination promoters, *Nigerian Journal of Botany,* 2:103-110.

Agboola, D. A. & Etejere, E.O. 1991 Studies on seed dormancy of selected economic tropical forest tree species. *Nigerian Journal of Botany*. 4:115-125

Bewley, J. D. & Black, M. 1994. Seeds: Physiology of development and germination 2nd edition. Plenum Press, New York. 445.

Carl, A. L. & Paul, E. K. 1975. Plant growth and development. 2nd edition. McGraw-Hill, Book company. New York. 229.

Corner, E. J. H. 1966. The natural history of palms. Weiden-feld and Nicolson. 20, New bond street, London.

Collinbourn, H. G. 2001. Palm seed germination. http://www.personal.u-net.com/~treetops/germinat.html.

Connely, S. & Wilson, N. 2001. Trees for semi-nomadic Farmers: a key to resilience. LEISA, Magazine on low external input and sustainable Agriculture. April, 2001, 17 (1). 10-11.

Crosby, M. R. *Palm plants.* In: Microsoft R Student 2007 (DVD). Redmond. W. A. Microsoft Corporation, 2006.

Esenewo, G. & Adebona, A. C. 1990. Effect of high temperature pretreatment on the germination of *Colypha mbracalifera. Nigerian Journal of Botany*. 3: 85-92.

Etejere, E. O., Fawole, M.O. & Sanni, A. 1982. Studies on the seed g rmination of *Parkia clappertoniana, Turialba* 32(2): 181-185.

Food and Agricultural Organisation of nthe United Nations (FAO) 2001. Techniques of Nursery Operations in Arid Zones, 8.

Jackson, G. 1968. The seedling morphology of *Botyrospermum Paraxodum. Journal of West African Science Association*. 13, (2) 10: 215-222.

Jorge, H., Ramiro, A. & Eric, G. 1998. Use of chemical treatments to induce seed germination in oil Palm 1:8.

Katherine, E. 1977. Anatomy of seed plants. 2nd edition. John Wiley and sons INC. New York.

Micheal, F. 1993. Seed Ecology. Chapman and Hall. 2-6 Boundary Row, London

Nigerian Institute for Forest Research (NIFOR). 1985. *Raphia* Palm; Its Propagation. Information, Extension and Research Liaison Services Division Bulletin No.6, 1: 5.

Nigerian Institute for Oil Palm Research (NIFOR) 1989. History, Atctivities and achievements, Nigerian Institute for Oil Palm Research. 2nd edition. Sadoh Press (Nig) Ltd. Benin City, Nigeria PP 10-11.

Olofinboba, M. O. 1977. Forestry: the need for improve management. Second University of Ilorin Lecture series. Ilorin, Nigeria.

Opeke, L. K. 1982. Tropical tree crops. Woye and Sons (Nig.) Ltd. Ilorin, Nigeria. 258-263.

Piggott, C. J. 1964. Coconut growing. Oxford University Press. London.

Purse glove J. W. 1974. Tropical Crops: Monocotyledons 2. Longman group Limited. VikasPublishing house P.V.t. Ltd. India.

Tomlinson, P. B. 1961. Anatomy of monocotyledons. Oxford University Press Britain.

Tran, V. W. & Cavanagh, A. K. 1984. *Structural aspects of dormancy*: In Seed Physiology Vol. 2. Germination and reserve mobilization (D. R. Murray ed) Academic Press, Sydney 1-44.

Werker, E. 1980. Seed dormancy as explained by the anatomy of embryo envelopes. *Israel Journal of Botany*. 3:11

Whitmore, F .C. 1977. Palms of Malaya. Oxford University Press, London