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

BY:

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FEBRUARY, 2005.

DECLARATION.

I hereby declare that this dissertation has been written by me and it is a record of my own research work. It has not been presented before in any previous application for a higher Degree.

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The above declaration is confirmed.

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CERTIFICATION.

This dissertation entitled "Studies on the germination and Seedling Characteristics of the Savanna Palms" by Salisu, Muhammad Tahir, meets the requirements governing the award of the Degree of Masters in Science Educational Biology of Ahmadu Bello University, Zaria, and is approved for its contribution to Scientific knowledge and literacy presentation.

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DEDICATION.

This dissertation is dedicated to my parents, Malam Muhammad Tahir Dankama, Aishatu Babale Dandago, my beloved wife Rabia'tu Ibrahim, my children Abdulbasit, Abdussalam, Muhammad, Aishatu, Abdulmalik, Abdulmajid, AbdulAzeez and other members of my family.

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ABSTRACT.

The research was conducted to determine the most effective physical and Sulphuric acid treatment suitable for faster germination in four indigenous Savanna Palm trees; *Borassus aethiopum, Hyphaene thebaica, Phoenix reclinata and Raphia sudanica*. From the four species studied, result of analysis of variance indicated that there was a significant difference among average days for germination, percentage germination and average height ($P < 0.05$). Seeds of the four species were found to have mechanical dormancy due to hard seed coats. Treatment with concentrated Sulphuric acid induced germination only in *Hyphaene* and to a lesser extent in *Borassus.* All treatments had significant effects on parameters tested on the four species, except in *Borassus* where there was no significant effect on percentage germination. The Savanna Palms were shown to exhibit a cryptogeal type of germination, which took place in two stages: (i) preparatory germination (ii) germination proper.

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CHAPTER ONE.

1.1 INTRODUCTION

Palms belong to the Family Palmae. About 225 genera with 2,600 species have been reported by Purseglove, (1974). Rendle, (1979), reported 140 genera with 1,200 species world over. While Tomlinson, (1961), Watson and Dallwitz (2000) reported about 205 genera with 2,500 species. Eight genera with sixteen different species are found in Nigeria (Keay, 1964).

Economically, Savanna Palm trees are very important. For example, these trees are sources of wood, fuel, fodder, while some play prominent roles in nutrient recycling and in agro-forestry practices (Conelly and Wilson, 2001). Sap of many species like *Hyphaene , Phoenix, Cocos* etc, yielded sugar and palm wine (about 500 – 1212 litres per annum) FAO, (2000). Fibers obtained from leaves are woven into mats, ropes, fans, bags, baskets, fish traps and other domestic utensils while the stem is used for planks (Hutchinson and Dalziel, 1937, Etejere, et al, 1982, Agboola and Adedire 1985, NIFOR, 1989, Esenowo, and Adebona, 1990, Conelly and Wilson, 2001).

Palm trees are able to withstand adverse conditions but they grow very slowly (Tomlinson, 1961). Seeds of most forest trees species are usually dormant and therefore do not germinate readily (Olofinboba, 1979, Agboola and Etejere, 1991, and Agboola, 1995). Some take one to

several months to germinate much longer than many trees. The hard layer commonly present in the fruit wall probably delays germination until it has softened (Sweeney, 1956, Whitmore, 1977, Werker, 1980, Tran ad Cavanagh 1984, Bewley and Black 1994). The plants of Savanna and other tropical Communities with well marked layers of grass are usually subjected to annual grass fires (Jackson,1968 Agboola, 1995) in addition early growth of Palm trees from seeds is slow and the young Palm has to build up its stem to full width before it can begin to grow upwards. Like most other tropical plants, many of the palm seedlings do not survive for long (Whitmore, 1977, Collingbourn, 2001).

Re-afforestation practices are usually centered on the generation of exotic and ornamental trees rather than the native trees particularly Palm trees. In addition, the indigenous Savanna Palm trees are exploited seriously for their economic and nutritional values. This is an additional reason why Palm trees in the Savanna region have a very low population and they are seriously threatened with extinction. Thus, there is the need to save the already existing Palm trees in this region and increase their population.

1.2 ORIGIN AND DISTRIBUTION OF THE PALMS.

Evidence of fossil remains, including stem, leaves and fruits has shown that palms reached further North in the late Cretaceous and Eocene periods. Likewise, the Family was well represented in central Europe and extended far

North during the Oligocene and Miocene periods (Corner, 1966, Rendle 1979). The Palm Family is pan tropical, but with sub tropical extention into California, North Carolina, Chile, Argentina, Italy, Greece, Asia minor; across North India and China to Korea, South Japan, NewZealand and South Africa. The four genera which occur both in Africa and Asia are *Phoenix, Hyphaene, Borassus* and *Calamus* (Corner, 1966).

From Swampy origin palms advanced with diminishing variety and greater specialization, to hill sides, mountains, savanna, deserts, seashores and borders of temperate regions. Gradually, they were able to survive the increasing adversity of lowered temperature and water supply (Corner, 1966).

1.3 MORPHOLOGICAL DESCRIPTION OF THE SAVANNA PALMS UNDER STUDY

1.3.1 *Borassus athiopum.* Hausa: 'Giginya'. Igbo: 'Ubiri'. Yoruba: 'Agbon – eye'.

Wide spread in Africa, locally abundant in Nigeria. It is a dioecious fan palm of about 24 meters high with 1.8 meters girth. Bark is grey and hard, more or less smooth above the middle in old trees, with remains of leaf stalk persisting in young trees. Leaves are palmate and V – Shaped about 3.5 meters long, divided to the middle into numerous narrow segments. It flowers in April with male and female flowers on separate trees. The Fruits formed around April, are very persistent and ripen shortly before the new flowers appear; they are orange, sweetly scented more or

less globose but flattened from top to the bottom, about 12 cm. in diameter, with the enlarged calyx forming a cup at the base; skin is smooth and tough, enclosing an edible fibrous pulp surrounding 1 – 3 hard seeds (Keay, 1964, Puseglove 1975) plate Ia/IIIa.

1.3.2. Hyphaene thebaica (Dum palm) Hausa: 'Goriba'

Wide spread in Middle East and Western India. It also extends from Senegal to Egypt, Sudan and Nigeria. It grows wild in the drier Savanna region and it is a dioecious palm with Y – branched trunk which is a rare character among the palms. It is 9 – 15 meters high, and 90-cm. girth. It is fairly smooth, with scars of fallen leaves. Leaves are palmate and V-shaped; about 1.2 meters long with blades divided onto segments. Leaf stalk is about 60cm long armed with curved thorns. It flowers in March with male and females on separate trees. It fruits in March persisting till next season flowers appear. The flowers are ovoid or slightly three lobed, up to 7.5 meters long, with a smooth hard brown coat containing a large and very hard stone. Young leaves are plated in strips, which are made into Mats, Baskets, Hats, etc. terminal meristem is tapped for palm wine (Keay, 1964, Purseglove, 1974) plate Ib /IIIb.

1.3.3. *Phoenix reclinata* (Wild Date) Hausa: 'Kajinjiri'. Igbo: 'Ngala'. Yoruba: 'Ookun'.

Wide spread in tropical and South Africa, and grows in coastal swamps and swampy grounds in the Savanna regions. Stem produces basal suckers forming clumps. It has a spiny dark and rough surface due to leaf remains. Stem is about 30 meters high and 60cm in girth.

Leaf is pinnate and V – shaped. It is about 1.5 – 3 meters long, with lower leaflets modified into sharp spines of about 5 – 6 cm long. Upper leaflets are about 30 cm long, by 2 cm broad. It flowers in October – May. Male and female flowers are on separate trees. It fruits around February. The fruits are about 2cm long, orange, turning dark brown when mature, edible and also medicinally useful e.g. burnt seeds are made into an ointment for treatment of ulcer. Strips of young fronds and their midribs are used to weave Mats, Bags, Hats, Band sieves etc. Stems are used for rafters, bed spreads etc. (Keay, 1964, Purseglove, 1974). Seeds with narrow grooves are suspected to be males while those with wider grooves, females. Spines fro leaves are used as tooth picks and fish traps (Okolo, *et al*, 2000). Plate IIa/IIIc.

1.3.4. Raphia sudanica. Hausa: 'Tukurwa'. Igbo: 'Ngwo'. Yoruba: ' Eriko'.

Wide spread in Senegal and Northern Nigeria. It is a tree with a stout trunk usually 2 – 3 meters high, but reaching 8 meters. Leaves are pinnate and - shaped, about 10 meters long, stiff and rather upright, leaflets margins and their midrib armed with fine blackish spines. It fruits only once before it dies producing up to 500 – 10,000 fruits; ellipsoid to top shaped 5 - 7 cm long by 3.5 – 5 cm across, covered with close fitting shiny dark mahogany – brown scales in 9 – 10 vertical rows; scales are flat or slightly convex. Palm wine is obtained by tapping the inflorescence before it emerges.

Scale – like flowers are present with the females located at the base while the males at the tip. *Raphia* fibre obtained from unopened leaflets is used in making Mats, Handbags, Hammocks and could be woven into Clothes, Ropes, Brushes etc. Mesocarp yields oil, which can be used industrially to manufacture cosmetics, hair cream and as food. Stems armed with petioles are raw materials to pulp and paper industries. It is hoped that with completion of investigation into the pulping of *Raphia* trunk and leaves, Nigeria will save a lot of foreign exchange currently used to import long fibered pulp abroad

(Keay, 1964, Purseglove, 1974, NIFOR, 1989). Plate IIb/IIId.

1.4 STATEMENT OF PROBLEM

Seeds of most trees are usually dormant and therefore, do not germinate readily (Olataye, 1968, Olofinboba, 1979, Agboola and Etejere, 1991, Agboola, 1995) David, 1999).

In nature, dormancy is overcome by abrasion or decay of seed coats, leaching out of inhibitory compounds on seed coats or in the embryo or by experiencing environmental conditions like chilling, fluctuating temperatures, or specific photoperiods which initiate the biochemical process that breaks dormancy (Michael (1993). The aforementioned processes were found to be very slow (Opeke, 1982, NIFOR, 1985, Agboola, 1995).

Dormancy has artificially been broken by a number of processes used by many workers throughout the world. Through scarification by scratching seeds with sand, paper, cutting with knife, pounding with sand, robbing over an abrasive slab, soaking in cold / hot water, dry or wet heat method, inoculation or the use of chemicals. These processes hastened faster germination and efficient growth. (Hussey 1958, Kozlowski, 1972, Camont and Jacquemared 1977, Kin 1981, Opeke, 1982, Nifor, 1985, Addae 1988, Agboola and Adedire 1995, F.A.O 2001).

1.5 JUSTIFICATION

1. There is the need to find out faster methods of growing palm trees easily for their population to increase.
2. There is the need to cultivate them in the Botanical gardens for study and research purposes.

This project was therefore designed with the following aim and objectives.

1.6 AIM AND OBJECTIVES

The aim of this study was to increase the population of the indigenous Savanna Palm trees through the following objectives:

1. To determine the effective physical and chemical treatment that will give faster germination in the Savanna Palm seeds.
2. To determine the type of germination common to Savanna Palm trees and their seedling characteristics.

CHAPTER TWO

2.0 LITERATURE REVIEW

The population of the Savanna trees fasces regular annual bush burning, exploitation and deforestation to meet man's diverse needs of farming, lumbering, housing and industrial development. These led to great modification of natural habitats of the crop[s, hence, their extinction is imminent (Agboola 1995) Similarly the re-generation of plants in tropics is confronted with a lot of problems like seed origin, degree of ripeness, age, collection, processing, storage, germination and seedling survival (Romberger and Mikola, 1964, Olataye, 1968, Olofinboba, 1979).

Palms are propagated by two methods; (i) from seeds, which should be collected from stout parents of known performance. (ii) From a clump by cutting off some leaves of the sucker plant and keeping in a shade first before planting (Tomlinson, 1961. Whitmore, 1977, Opeke, 1982, NIFOR, 1985, FAO, 2001). Many seeds germinate very slowly often requiring weeks, months, or even years (Hutchins, 1965, NIFOR, 1985, Jorge, *et al*, 1998, FAO 2001). A physiologically sound seed remains quiescent after exposure to all favorable conditions necessary for germination due to dormancy (Kozlowski, 1972, Keely. e*t al*, 1985, Bell, 1994, Agboola, 1995) Palms show varying degree of dormancy due to their hard seed coat or pericarp which are impermeable to water and gases, during which they will not germinate (Whitmore, 1977, NIFOR, 1985). Chemical dormancy may be due to inhibitory chemicals present in fruit, seed, tissue and

covering (Fasidi and Olofinboba, 1975, Ashton and Frankenberg, 1976, Katherine, 1977, Hussey, 1958 David, 1999, F.A.O. 2001). Seed dormancy in some cases may be due to immature embryo or proper metabolisation of food and metabolites for the embryo is prevented (Odetola and Kozlowski, 1979, David 1999).

Hard seed coat acts as a mechanical barrier restricting water uptake by the impermeable outer part of the epidermal layer of malphigian cells, hence restraining expansion of the radicle and manifestation of germination (Sweeney 1956, Werker 1980, Tran and Cavanagh 1984, Bewley and Black 1994). Hard Seed dormancy may also have physical and chemical components that vary from specie to specie (Morris 2000). A large seed size is an adaptation for drought avoidance by conferring on the seedling the ability to make early root crops to reach the moist layers below the surface. A large seed has advantage over smaller ones as its roots can grow more quickly and its shoots can emerge successfully from greater depth (Michael 1993). Hard seeded species limit germination by restriction of oxygen availability to the embryo, there by restraining it's growth (Grose, 1962) Hagon, 1976, Mott and Groves, 1981). Induction of dormancy is related to the relative seed concentration of Abscissic Acid (Khan 1975, Hilhorst and Karssen, 1992). Later production of significant concentrations of Giberrellic Acid leads to germination (Karssen, *et al* 1987).

Therefore, there is the need to break the dormancy and cause the seed to germinate readily. Seed scarification and chemical techniques had been used to hasten germination and sprouting of some palm seeds which were later sown directly into soil to produce seedlings (Whitmore, 1979, NIFOR, 1985, F.A.O, 2001).

Palm seeds germinate best if scratched, or filed to allow water penetration; sand papered or soaked in cold / hot water or acid and later placed in vermiculite in air tight container and incubated at a temperature ranging between 32^{o} to 39^{oc}. The seed germinate quickly when planted in a well-drained composed soil (Rees, 1963, Hutchins 1965, Opeke, 1982 Baskin and Baskin 1989, Jorge *et al*, 1998. Collingbourne 2001, FAO 2001). Different seeds have different temperature range within which they germinate. Similarly, some seeds are dormant in darkness (Paul and Theodore 1960, Mayer, 1963, Rees 1963, Romberger, 1964).

Generally, Palm fruits have hard coats enclosing the true seeds, except in date palm and its wild allies where the endosperm of the seed is surrounded by membranous pellicle as inner layer of the fruit wall (Corner, 1966) Oil Palm seeds are Characterized by a mass of oily endosperm with a thick shell. These have limited the penetration of acid treatment (Jorge *et al* 1998). However, Amberger, 1983, observed that longer periods of exposure produce a negative effect on germination, which may be due to toxicity. High dose could even have herbicidal effect.

2.2 GERMINATION IN PALMS

The availability of soil moisture is the first requirement for seed germination through its effect on inhibition (Zohar, *et al.* 1975). Morphological changes that occur during germination are the same in all seeds. Most seeds absorb additional water to start off biochemical and Physiological processes involved in germination. These include swelling of the seed, formation of enzyme system, and commencement of active growth in the radicle. Activity in the plumule begins when a root has been formed. (Paul and Theodore, 1960, Steward, 1972, Carl and Paul 1975). Germination can be complete when the seedlings have produced enough photosynthetic surface to supply their own food (Paul and Theodore, 1960) A feature where germination mechanism carry the plumule below the soil surface before shoot elongation occurs is termed cryptogeal germination (Clarkson and Clifford 1987). The mechanism is seen as an adaptation for protecting the embryonic shoot from fire (Jackson, 1974). Retention of the testa protects some germinating seeds from decay, an advantage in moist soils, and from desiccation, an advantage in periodically dry soils. It also prevents early spreading of the cotyldons that assists elongation through the soil and litter (Grant *et al* 1996, Lamont and Milberg, 1997).

Early emergence doesn't always result in a growth advantage or increased fecundity (Kalisz), 1986. Late emergence also does not always result in an

increased probability of survival (Abul faith and Bazzaz, 1979, Miller 1987).

Geotropy is a common feature of germinating palm seed. In many species of Palms, the Cotyledonary sheath elongates pushing the shoot apex into the ground; up to 60cm deep, in *Borassus species* and *Hyphaene species.* This in *Raphia species* is followed by apogeotropic growth where massive stem apex is buried to a depth of up to 1m, below the soil (Tomlinson, 1961, Purseglove, 1974). On germination, the Cotyledon is never erected as a green Photosynthetic organ. Petiole, leaf sheath, or a ligule can be recognized. Apex of the Cotyledon is enlarged as suctorial haustorium embedded in the endosperm of the seed; the food reserves of which is absorbed and transmitted to the seedling. The sheath extends so that the embryo is exerted from the seed. e.g. in *Phoenix specie.* After the growth of cotyledon ceases, the plumule is excerted, piercing the tabular cotyledonary sheath, and growth of the radicle commences (Tomlinson 1961).

Gartin 1912, as reported by Tomlinson 1961 observed that germination in Palm seeds take place in two phases; Depreparation: where the embryo is extruded from the seed although its parts remain enclosed within the sheathing structures. Degermination Popre: where the plumule and the radicle break through the sheathing organs and become visible externally. Similarly, palms have been divided into two types based on mode of

germination (i) Admotive germination; Elongation of the Cotyledon is slight with a short cotyledonary ligule (ii) Remotive germination: elongation of the Cotyledon is marked and is either ligulate or eligulate (Tomlinson, 1960 Corner, 1966).

In some palms, the first leaf above the Cotyledon has a small Lamina, while others have a scale leaf consisting of a sheath without lamina as in *Phoenix specie*. In others, there are two to three or more scales before the first foliage leaf, which may be undivided or lanceolate (as in *Phoenix specie),* Obovate (widened distally) or split from apex into two halves, or it is Palmate or pinnate (Tomlinson, 1961, Corner, 1966). In several Palms, first foliage leaves are compound (as in *Raphia specie*).

Five Juvenile Foliage leaves types have been recognized in Palms. These are (1) simple and Lanceolate with few leaflets inserted below a simple terminal leaflets e.g. in feather palms with induplicate leaflet (ii) foliage leaf is simple and lanceolate but succeeded by leaves whose lamina is digitate. Later leaves are larger and more deeply segmented; e.g. In fan palms like *Borassus specie* (iii) Bifid Foliage leaves succeeded by Paripinnate leaves with a bifid terminal leaflet e.g. In feather palms with reduplicate leaflet like *Cocos specie* (iv) Lanceolate foliage leaves succeeded by irregular segmented leaves e.g. in Cocoid palms (v) Lanceolate foliage leaf succeeded by bifid leaves before paripinnate leaves are produced (Tomlinson, 1961).

2.3 SEEDLING CHARACTERISTICS

Bigger Palm seedlings are produced from larger seeds. They provide an ample reserve of nutrients during the period immediately after germination. This enables the seedling to achieve a critical size and put in a position to capture external resources in competition with other plants. Seedlings from large seeds have higher shoot/ root ratios. Large seeds achieve initial increase in height without having to Photosynthesize, and use their cotyledons to provide the resources for this; while small seeds with small resources, need to photosynthesize immediately they germinate using their cotyledons. When the new seedling emerges, light is experienced; the stem apex become unhooked, and the leaf enlargements begin. As the growth of the shoot and root proceeds, dependence on internal resources is gradually reduced and external supply of carbon and minerals are exploited (Corner, 1966, Carl and Paul, 1975, Michael, 1993).

The seedling has no difficulty in forcing its way out of the seed of most Palms. The thin stone or fibrous shell of endocarp surrounding it rapture easily, and decay at the time of germination. The seedling of Palms build up an inverted cone or an onion like structure from which the massive primary stem commences upward growth (Corner, 1966, Carl and Paul, 1975).

The first leaves usually have undivided plated blades, and later developed ones are of increasing size and complexity. No secondary thickening has

been observed in roots, and primary seedling roots are replaced by adventitious roots from the lower internodes of the stem. As the stem increases in diameter, new roots are added at higher levels to form a massive basal cushion, so that the youngest root may be above the soil surface; According to Tomlinson 1961, Cook 1941, this is called Rhizotyle. First root is short-lived, and is soon followed by erect adventitious roots formed at the base of the seedling stem (Tomlinson, 1961, Corner, 1966, Whitmore, 1977).

The authors have characterized early development in Palms into five types:

i. Eriartea: The first internodes of the seedlings are elongated so that an elongated stem with unthickened base is produced gradually increasing in diameter. This obconical structure is supported by thick aerial prop roots growing obliquely downwards from the lower internodes.

ii. Corponicia: The seedling is buried in the soil by extension of the cotyledon. It grows vertically upwards, producing short internodes of increasing diameter forming an obconical when it grows to the soil surface. It forms a rigid foundation for aerial system and develops a fibrous root system from the lowest internodes.

iii. Sabal type: Early growth of the seedling is obliquely down wards and adventitious roots are often limited to the lower surface of the oblique, while bulbus stem is being formed. But in others the stem remains rhizomatous.

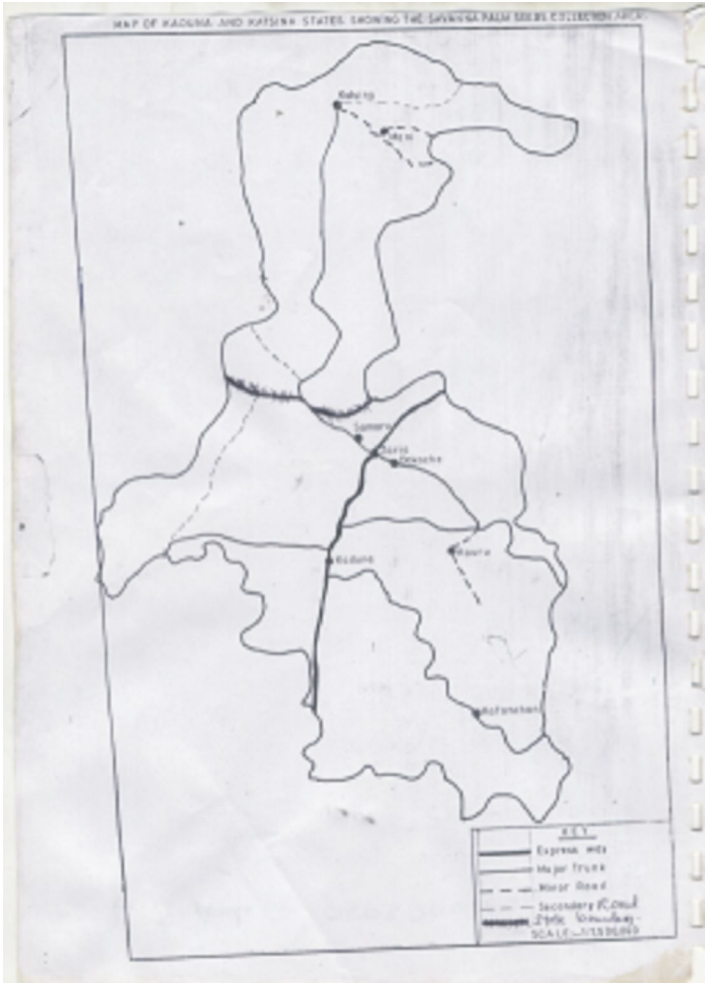
iv. Cocostype: Cotyledon is scarcely elongated and early developed of the stem involves a succession of short erect internodes from which arise numerous adventitious roots. When full width of the stem has been achieved, succeeding internodes become more elongated and an erect trunck becomes evident.

v. Bactristype: Early growth of the stem is horizontal and a creeping rhizome is formed.

CHAPTER THREE

3.1 MATERIAL AND METHOD

Two hundred and eighty seeds each of the following four indigenous Savanna Palms were collected from the month of February – April, 2001, from different locations within the Northern Savanna Zone. These were Samaru, Dakace, Kauru (in Kaduna State) and Mani (in Katsina State) as indicated in the map.



Borassus *aethiopum* (H. 'Giginya', I. 'Ubiri', Y. 'Agbon- eye')

Hyphaene *thebaica* (H. 'Goruba')

Poenix *reclinata* (H. 'Kajinjiri', I. 'Ngala'. Y. 'Ookun').

Raphia *sudanica* (H. 'Tukurwa'.I. 'Ngwo', Y.'Eriko').

3.2 STUDY AREA:

The research was conducted in the Biological Sciences Department of Ahmadu Bello University, Samaru. (Lat. 11^{o} 11' N, long. 07^{o} 38E) 686 m above the sea level.

3.3 TREATMENT.

Seeds of approximate age and size from each of the four different species of Savanna Palm were selected and divided into eight different groups. In each of the group, except control and concentrated sulphuric acid treatment, selected seeds were divided into two sub groups of twenty seeds each and subjected to the following treatments:

1. Control (untreated)
2. Seeds soaked in Cold water for 2 days with and without hole. The hole was made using a 4-inch nail to puncture the bottom end of the seed shell.
3. Seeds soaked in cold water for 4 days with and without hole.
4. Seeds soaked in cold water for 6 days with and without hole.
5. Seeds socked in Cold water for 2 days with and without hole and placed in sawdust.

6. Seeds soaked in Cold water for 4 days with and without hole and placed in sawdust.
7. Seeds soaked in Cold water for 6 days with and without hole and placed in sawdust.
8. Seeds soaked in concentrated Sulphuric acid (98%) for 30 minutes (Hutchinson, 1965 Rose, 1965, Opeke, 1982, Collingbourne, 2001).

3.4 PLANTING

After soaking in water some of the seeds were sealed in Polythene bags containing sterilized Sawdust and kept for regular checking of sprouting of Cotyledon stalk for onward planting in a compost soil. Other seeds were directly planted into soil after soaking (Whitmore, 1977 Opeke, 1982, NIFOR, 1985, Collingbourne, 2001).

3.5 OBSERVATION AND DATA COLLECTION.

The following parameters were tested to compare and determine the most effective treatment.

1. Average time for germination:

   It was determined by $\frac{\text{No of Days to germinate per seedling}}{\text{Total No of replicates}}$

2. Percentage germination: $\frac{\text{No of Seedlings}}{\text{No of Seeds sown}} \times 100$. (source: Fatima 2003).

3. Average height: $\frac{\text{Last measurement of each seedling}}{\text{No of replicates.}}$

Observation was also made on the nature, and mode of germination exhibited by the four different Savanna Palm species. Seedling characteristics were also observed to determine the number of foliage leaves obtainable; their forms, arrangement and veination.

3.5.1. SEEDLING HEIGHT AND ROOT LENGTH

The heights of the seedling and root length were measured in cm immediately after germination and at other stages of development, at two weeks intervals for 14 Months. This was by holding the leaf erect, taking the highest Point as record. The same was done to the root.

3.5.2 STATISTICAL ANALYSIS.

For analysis of data collected in this study, Duncan multiple range test (DMRT) was carried out to test for least significant difference (LSD). All test of significant were carried out at 0.05 levels.

CHAPTER FOUR.

4.1. RESULT.

Result of the analysis of variance for all the treatments on the germination of *Borassus Specie* indicated that, average days to germination, percentage germination, and average height, were highly significant $P<0.05$. Table I.

4.1.1. The effect of the different treatments on the germination of *Borassus aethiopum* are presented in Table II. The average days for germination indicated that seeds soaked in concentrated sulphuric acid (H_2SO_4) for thirty minutes without hole took lesser days to germinate. It was followed by treatments soaked in water for four days with hole, soaked in water for six days with hole and put in sawdust. These treatments had significant effect on days to germination (in *Borassus)* over long but variable time frames (six – twelve months). However, highest days to germination were observed with treatment soaked in water for four days without hole, soaked in water for two days with hole and placed in sawdust, soaked in water for two days with hole and soaked in water for six days without hole and put in Sawdust which shows no significant difference compared with the (untreated) control which on the average took three hundred and seventy days to germinate.

Percentage germination in *Borassus* indicated that, the highest germination were observed with treatments soaked in waster for two days with hole, soaked in water for four days with hole, soaked in water for six days with hole, soaked in water for two days without hole, soaked in water for four days without hole, which shows no significant different compared to the control. Which were followed by treatment soaked in sulphuric acid for thirty minutes without hole, soaked in water for six days without hole, soaked in water for six days with hole and placed in Sawdust, soaked in water for six days with hole and placed in Sawdust, soaked in water for two days without hole and placed in sawdust, and soaked in water for six days without hole.

Highest average heights were observed with treatment soaked in water for two days without hole and placed in sawdust, soaked in water for four days without hole, soaked in water for two days with hole and put in sawdust, soaked in water for four days with hole, soaked in water for two days with hole, soaked in water for six days without hole. However, the lowest average heights were observed with treatments soaked in water for six days without hole and placed in sawdust, soaked in concentrated sulphuric acid for thirty minutes without hole and soaked in water for six days with hole and placed in sawdust, which showed no significant difference compared to the control.

Table II: Mean performance of the different treatments on the gernination of *Borassus aethiopum*

Treatment	Average days for germination proper	Percentage germination	Average height
soaked in water for 2 days with hole.	351.73^{ab}	4.25^{a}	78.23^{c}
soaked in water for 4 days with hole.	255. 73^{d}	4.00^{a}	86.63^{b}
soaked in water for 6 days with hole.	347.95ab	4.25^{a}	67.23^{b}
soaked in water for 2 days without hole.	382.81^{ab}	4.00^{a}	65.43^{d}
soaked in water for 4 days without hole.	390.76^{a}	4.00^{a}	92.68^{ab}
soaked in water for 6 days without hole.	355.75^{ab}	2.75^{ab}	71.83^{cd}
soaked in water for 2 days with hole and put in sawdust.	269.00^{bc}	2.00^{b}	87.50^{b}
-	- -	- - -	- -
soaked in water for 6 days with hole and put in sawdust.	260.00^{c}	2.00^{b}	17.60^{f}
soaked in water for 2 days without hole and put in sawdust.	353.00^{ab}	2.00^{b}	115.70^{a}
soaked in water for 6 days without hole and put in sawdust.	342.00^{b}	2.00^{b}	45.82^{e}
Soaked in sulphuric acid for 30 minutes	162.67^{e}	3.00^{ab}	45.68^{e}
CONTROL	370.75^{ab}	4.00^{a}	45.83^{e}
	SE $\pm$ 340.05	SE $\pm$ 3.59	SE $\pm$71.95

Means with the same letters within the same column are not significantly different according to DMRT at 5% level.

4.2 Result of analysis of variance for all the treatments on the germination of *Hyphaene thebaica* indicated that average days for germination, percentage germination, and average height, were highly significant $P<0.\overline{0}5$. Table III.

4.2.1.The effect of the different treatments on the germination of Hyphaene *thebaica* is presented in table IV. Average days for germination indicated that least days to germination were observed with treatment soaked in concentrated sulphuric acid for thirty minutes without hole. It was followed by treatments soaked in water for two days without hole and placed in sawdust, soaked in water for tow days without hole, soaked in water for six days without hole, which shows significant effect on days to germination (two-three months) however, the highest days to germination were observed with treatments soaked in water for six days without hole and placed in sawdust, soaked in water for four days with hole and placed in sawdust, soaked in water for two days with hole, soaked in water for four days without hole and placed in sawdust, which were followed by treatments soaked in water for four days without hole, soaked in water for four days with hole, soaked in water for six days with hole.

The Percentage germination indicted that, highest germination counts were observed with treatment soaked in water for two days without hole, soaked in water for four days without hole, soaked in water for six days with hole, soaked in sulphuric acid for thirty minutes soaked in water for six days without hole soaked in water for six days with hole, which were followed by treatment soaked in water for two days with hole, soaked in water for four days without hole and placed in sawdust. These treatments show significant difference compared to the control. However, the least germination counts was observed with treatment soaked in water for two days without hole and placed in sawdust, followed by

treatments soaked in water for two days with hole and placed in sawdust, soaked in water for four days with hole and placed in sawdust.

Highest average heights were observed with treatments soaked in water for four days without hole, soaked in water for two days without hole, which shows significant different compared to the control. These were followed by treatments soaked in water for two days with hole and placed in sawdust, soaked in water for six days without hole and placed in sawdust, soaked in water for six days without hole, soaked in water for four days with hole, soaked in water for four days with hole and placed in Sawdust, soaked in water for four days with hole and placed in sawdust, soaked in water for six days with hole and placed in sawdust, soaked in water for four days without hole and placed with treatment soaked in water for two days with hole, followed by treatments soaked in sulphuric acid for thirty minutes without hole, soaked in water for two days without hole and placed in sawdust, soaked in water for six days with hole.

Table IV: Mean performance of the different treatments on *Hypheene thebaica*

Treatment and soaking time	Average days to germination	Percentage germination	Average height
soaked in water for 2 days with hole.	111.69c	3.00b	16.00f
soaked in water for 4 days with hole.	98.43d	3.50ab	39.53cd
soaked in water for 6 days with hole.	97.66d	4.00ab	21.63e
soaked in water for 2 days without hole.	88.37f	4.50a	58.05b
soaked in water for 4 days without hole.	99.17d	4.25ab	60.60[9]
soaked in water for 6 days without hole.	90.56e	3.50ab	39.98cd
soaked in water for 2 days with hole and put in sawdust.	125.63b	2.75c	47.63c
soaked in water for 4 days with hole and put in sawdust.	116.50cb	2.75c	38.25cd
soaked in water for 6 days with hole and put in sawdust.	125.65	3.25ab	35.65d
soaked in water for 2 days without hole and put in sawdust.	81.33fg	1.00b	21.23e
soaked in water for 4 days with hole and put in sawdust.	103.00cd	3.00b	24.60de
soaked in water for 6 days without hole and put in sawdust.	150.00a	3.00b	46.90c
Soaked in sulphuric acid for 30 minutes	70.39g	4.00ab	22.15e
CONTROL	95.19de	2.25c	55.38b
	SE $\pm$ 101.51	SE $\pm$ 3.27	SE $+$ 39.71

Means with the same letters within the same column are not significantly different according to DMRT at 5% level.

4.3 Analysis of variance for all the treatment on *phoenix reclinata* indicated that, average days for germination, percentage germination, average height were highly significant P< 0.05. Table V.

4.3.1. The effect of the different treatments on the germination of *phoenix reclinata* are presented in Table VI. Average days for germination indicated that the least days to germination was observed with treatments soaked in water for two days with hole and placed in sawdust, soaked in water for four days without hole and placed in sawdust, soaked in water for two days without hole and placed in sawdust, and soaked in water for six days without hole and placed in sawdust, which shows significant different compared to the control. However, the highest days to germination were observed with treatments soaked in water for four days with hole and placed in sawdust, soaked in water for two days without hole and soaked in water for two days with hole, these were followed by treatments soaked in water for four days with hole, soaked in water for six days with hole and placed in sawdust, soaked in water for six days without hole, percentage germination indicated that, highest germination was observed with treatment soaked in water for two days without hole, which shows a significant different compared to the control. It was followed by treatments soaked in water for six days with hole and placed in sawdust, soaked in water for four days with hole, soaked in water for four days without hole, soaked in water for four days without hole and placed in sawdust, soaked in water for six days without hole and placed in sawdust, soaked in water for six days without hole and soaked in

water for six days with hole. However, the least germination was observed with treatments soaked in water for two days without hole and placed in sawdust, soaked in water for two days with hole and placed in sawdust, and soaked in water for four days with hole and placed in sawdust.

Average height indicated that, the highest heights was observed with treatments soaked in water for four days with hole, soaked in water for two days without hole and placed in sawdust, soaked in water for six days without hole and placed in sawdust, soaked in water for four days without hole and placed in sawdust, soaked in water for two days with hole, and soaked in water for six days with hole and placed in sawdust, which show a significant different compared to the control. However, the least means were observed with treatments soaked in water for two days without hole, soaked in water for four days without hole, soaked in water for two days with hole, soaked in water for six days without hole, and soaked in water for four days with hole, and placed in sawdust.

Table VIII. The effect of the different treatments on the germination of *Phoenix reclinata*

Treatment and soaking time	Average days for germination proper	Percentage germination	Average height
Soaked in water for 2 days with hole.	48.58cb	4.50ab	34.75b
Soaked in water for 4 days with hole.	45.61cb	4.25b	37.35a
Soaked in water for 6 days with hole.	44.34c	3.00cb	24.55e
Soaked in water for 2 days without hole.	50.45b	5.00a	27.93cd
soaked in water for 4 days without hole.	59.46a	4.00b	26.43d
soaked in water for 6 days without hole.	44.00c	3.25cb	23.25f
soaked in water for 2 days with hole and put in sawdust.	35.19d	2.50c	25.65d
soaked in water for 4 days with hole and put in sawdust.	54.33ab	2.50c	21.33g
soaked in water for 6 days with hole and put in sawdust.	45.33c	4.67ab	32.53c
Soaked in water for 2 days without hole and put in sawdust.	37.99cd	2.75c	36.00ab
soaked in water for 4 days without hole and put in sawdust.	35.31d	3.75cb	35.40b
soaked in water for 6 days without hole and put in sawdust.	38.07cd	3.50cb	36.00ab
CONTROL	47.13cb	4.75ab	26.53d
	SE $\pm$ 45.05	SE $\pm$ 45.05	SE $\pm$ 29.94

4.4 MODE OF GERMINATION AND SEEDLING CHARACTERISTICS.

4.4.1 *Borassus:*

The Fibrous shell of the endocarp did not rapture easily, for it decayed gradually. This seemed to cause the long delay in germination of *Borassus* (about 6-12 months) compared to the other Palms under study.

Cotyledonary sheaths elongated slightly pushing the shoot apex into the ground, about 12.5 CM, forming a swelling towards the tip, with the seed attached. Radicle formed below the swelling (Plate IVa).

Cotyledonary stalk (an edible storage organ) with a shell about 41.4cm long, a tap and adventitious roots formed and buried to a depth of 32.3 cm. Similarly germination commenced here with the emergence of a non-Photosynthetic plumule, about 0.9cm long. The young seedling was attached to the seed (Plate IVb).

Foliage leaf with a Lamina was lanceolate and segmented. The covering of the storage organ disappeared. Taproot with adventitious roots became more established and buried to a depth of 64.6cm into the soil (Plate IVc).

Second foliage leaf with a Lamina and a brownish scar at the leaf apex was formed. Leaves were becoming deeply segmented. There was also a Cotyledon stalk with a long tap root, and adventitious roots branched into a fibrous root system, with root hairs being formed, and buried to a depth of 99.7cm into the soil. (Plate IVd).

Cotyledonary stalk reached its full width, then splited and the stem commenced upward growth. Third leaf became palmate as in C*orrypha* and *Hyphaene*. Cotyledonary stalk with roots buried to a depth of 135.cm (1.3m) into the soil. This plant was about five months old after germination. Leaves increased in size and complexity and were V- shaped as in P*hoenix* and *Hyphaene* (Plate IV e and f).

4.4.2. Hyphaene:

The Fibrous shell surrounding the endosperm easily ruptured, and decayed at the on-set of the germination. Non-photosynthetic cotyledonary sheath elongated pushing the shoot apex into the soil up to about 4.6cm (Plate Va). After the growth of the Cotyledon ceased, at about 47cm deep, the non-green plumule was exerted by piercing the Cotyledonary sheath and growth of the radicle commenced (Plate Vb).

The First foliage leaf was simple, obovate and lanceolate tapering at the tip. Seedling remained attached to the seed. Adventitious root and root hairs become more established. Top brownish root was about 93cm deep. (Plate Vc).

Leaves became large, and taproot was about 137.5cm (1.4 meters) forming a fibrous root system. Young whitish stem of about 14cm long developed. (Plate Vd).

Stem commenced upward growth, adventitious roots formed at the base of the seedling's stem. Thus, Stem enlarged and more leaves were

formed. It was also observed that subsequent leaves were of increasing height

than the first ones. Leaves were V shaped as in *Phoenix* and *Borassus* (Plates V e and f).

4.4.3 Phoenix.

The thin stone ruptured, and the cotyledonary sheath extended so that the embryo was exerted from the seed. Elongation of the cotyledon was slight about 3cm long. It was still attached to the seed. (Plate VI a).

Growth of the Cotyledon ceased and a photosynthetic plumule was exerted by piercing through the cotyledonary sheath. Adventitious roots began to develop from the radicle and buried to a depth of 11.3cm long (Plate VI b).

Stem began to develop with adventitious roots being formed. The first foliage leaf with a digitate Lamina and undivided pleated blades became evident. Taproot was about 13cm long (Plate VI c).

Second Photosynthetic foliage leaf with a developing stem. Tap root and root hairs formed and buried to about 24.7cm deep (Plate VI d). Third leaf with digitate lamina and pinnate arrangement appeared. Fibrous root system became established and the root was about 28.4 cm deep into the soil (Plate VI e).

At the fourth leaf stage, stem became more established. Adventitious roots with root hairs became evident and it was about 49.7 cm deep.

Leaves increased in size, segment and complexity. They were V -shaped as in *Borassus* (Plate VI f).

4.4.4 Raphia

This is a perennial and riverine palm tree, and possibly because the environment grown under this study was not suitable, only six seeds germinated, (2.1%), three of which died. Therefore, some stages of growth and development could not be followed.

The Cotyledon elongated into the soil up to 24.3cm deep. The plumule emerged as a brownish structure independent of the cotyledon stalk. This is contrary to what is obtainable in the other three Palms under study. There were no signs of root development at this stage; 5 weeks after planting (Plate VII a).

The plumule gradually turned green and compound foliage leaves emerged piercing it. Taproot developed with branch root and root hairs buried to a depth of about 28 cm into the soil (Plate VII b).

Foliage leaves were bifid, inverted ^ - shaped (as in C*ocos and Elaeis* etc) and fully photosynthetic with a pair of opposite terminal leaflet. The stem was fully taking shape with points for new leaves to emerge. Roots were becoming complex and established up to a depth of about 29.9cm long (Plate VII c). First foliage leaves were compound.

CHAPTER FIVE

5.1. GENERAL DISCUSSION.

The effect of the different treatments indicated that soaking in concentrated sulphuric acid for thirty minutes without hole hastened germination in *Hyphaene thebaica* (about 72 days), followed by *Borassus aethiopum*, (163 days), whereas there was no germination both in *Phoenix reclinata* and *Raphia sudanica*. Seeds of *Borassus* and *Hyphaene* might have been large enough, with a thicker shell to limit the penetration of the acid, while seeds of *Phoenix* and *Raphia* because of their soft shell, the chemical might be toxic enough (with long duration of soaking) to penetrate their endosperm and destroy their embryo, hence restraining their germination. It is therefore possible that longer exposure to acid produced a negative effect on some Savanna Palms germination; especially *Phoenix* and *Raphia*. Similar finding was reported by Amberger (1983), working on Grapevines where he observed that longer period of exposure to chemical acid produced a negative effect on germination, and toxicity and high dose could even have herbicidal effect. Similarly, seeds soaked in water for two, four and six days with and without hole and placed in Polythene bag containing sawdust significantly hastened days for germination in *Phoenix* and *Hyphaene*, followed by *Borassus*, with no effect on *Raphia*. This can be attributed to their varying degrees of size and hardness of seed coat. And this probably shows that seeds of *Phoenix* and *Hyphane* are not dormant in darkness (Polythene bag), followed by *Borassus.* But *Raphia* seems to be completely dormant in darkness.

This is as reported by Romberger and Mikola (1964), that some seeds are dormant in darkness but exposure to light breaks their dormancy. Similarly, seeds of some plant will not germinate unless exposed to air. (Paul and Theodore, 1960). And impairment of oxygen supply to the embryo due to hard coat was the mechanism for preventing germination (Mott and Groves 1981).

Rate of germination also, depends on the seed size and hardness of their respective coats and endosperms. Similar finding was reported by Corner, (1966), who observed that slowness in palms germination is a measure of their massiveness. And palm seed are stones enclosing the true seeds except in date palm and its wild allies where the endosperm of the seed is surrounded by membranous pellicle as inner layer of the fruit wall. Likewise, Grose, (1962), Hagon, (1976), Mott and Groves, (1981), reported that hard seeded species limit germination, thereby restraining its growth. Similarly, Morris, (2000), reported that hard dormancy has physical and chemical components, which vary from specie to specie.

In *Borassus* highest percentage germination was shown by the untreated seeds (control). However, treated seeds of Phoenix had a better percentage germination (75.8%), followed by *Hyphaene (74%),*

and lastly treated *Borassus* (42.2%). This might be due to differences in the Morphological and Physiological make up of the palms and their seeds. In Borassus for example, normal temperature was probably not enough to activate germination via the sawdust treatment. Darkness in the polythene bag might

also have delayed the germination in Borassus compared to the *Hyphaene* and *Phoenix*.

Similarly, moisture content of the sawdust was probably not enough to enhance germination depending on the hardness of the seed coat, which is a barrier to water absorption, and this mechanically, prevented the inner tissues from absorbing and expanding. This is in accordance with the findings of Romberger and Mikola, (1964), and Mayer and Poljekoff (1963) who reported that different seeds have different temperature ranges within which they germinate. And some seeds are dormant in darkness. Likewise, interaction has been reported between light and temperature. Resting seeds must absorb a certain amount of water before they are able to resume their active physiological process. Similarly, Sweeney, 1956, Odetola and Kozlowski, 1979, Werker, 1980, Tran and Cavanagh, 1984, Bewley and Black, 1994 reported that hard seed coat act as a barrier restricting water uptake by the impermeable outer part of the epidermal layer of Malphigian cells hence restraining expansion of the radicle and manifestation of germination.

Borassus has the highest height followed by *Hyphaene* and *Phoenix* respectively. This may be associated with their varying degrees in seed size, height at adult stage, and differences in their genetical composition. This might also be connected to their common character of slow growth. Similar finding was reported by Whitmore, (1977) and Collingbourne, (2000) who reported that, early growth of palm tree from seeds is lower. This is also in accordance with

finding of Michael (1993), who reported that, a large seed has advantage over smaller one; its roots can grow more quickly, and its shoots emerge successfully from greater depth. Likewise, Corner, 1966, Carl and Paul, 1975, Michael, 1993, reported that seedling from large seeds have higher shoot/root ratios. Because they provide ample reserve nutrients which enable the seedling to achieve a critical size advantage over those from smaller seeds.

5.2 MODE OF GERMINATION AND SEEDLING CHARACTERISTICS.

5.2.1. Borassus:

The Fibrous shell of the endocarp do not rapture easily, for it decay gradually. This seems to cause the long delay in germination of *Borassus* (about 6-12 months) compared to other Palms under study. This is contrary to the findings of Tomlinson (1961), Corner (1966) and Whitmore (1977), which stated that the endocarp in palms rupture easily. Similarly, according to Piggott (1964) roots and leaves appear four months after planting, but with some nuts, even on good conditions it can take up to one year.

Cotyledonary sheaths elongate slightly pushing the shoot apex into the ground, about 12.5 CM, forming a swelling towards the tip, with the seed attached. Radicle formed below the swelling (Plate IVa). This is in accordance the finding of Purseglove (1974) that cotyledonary sheaths elongate pushing the shoot apex into the ground at the age of two months. This stage as reported by

Tomlinson (1961), was described by Gartin (1912) as germination depreparation (i.e. preparatory germination).

Cotyledonary stalk (an edible storage organ) with a shell about 41.4cm long, a tap and adventitious roots formed and buried to a depth of 32.3 cm. Similarly germination commences here with the emergence of a non- Photosynthetic plumule, about .9cm long. The young seedling is attached to the seed (Plate Ivb). This as reported Tomlinson (1961), according to Ginies (1951), is to enable the young seedling absorbs food reserve from the endosperm of the seed. Likewise, Gartin (1912), according to Tomlinson (1961), called this stage degermination popre (i.e germination proper).

Foliage leaf with a Lamina is lanceolate and segmented. The covering of the storage organ disappeared. Taproot with adventitious roots is becoming more established and buried to a depth of 64.6cm into the soil (Plate IVc).

Second foliage leaf with a Lamina and a brownish scar at the leaf apex. Leaves are becoming deeply segmented. Also, there is Cotyledon stalk with a long tap root, and adventitious roots branched into a fibrous root system, with root hairs being formed, and buried to a depth of 99.7cm into the soil. (Plate IVd). Tomlinson (1961), have recognized these types of foliage leaves.

Cotyledonary stalk reached its full width, therefore splits and stem commences upward growth. Third leaf becomes palmate as in *corrypha* and *Hyphaene*. Cotyledonary stalk with roots buried to a depth of 135.cm (1.3m) into the soil. This plant is about five months old after germination. Leaves increased

in size and complexity and are V- shaped as in *phoenix* and *Hyphaene* (Plate IV e and f). This type of development was termed "sabal type" by Tomlinson (1961), Corner (1966) and Whitmore (1977). Similarly, this root system as reported by Tomlinson (1961), is in accordance to the findings of Cook (1941) who gave it the name Rhizotyle root system.

5.2.2 Hyphaene:

The Fibrous shell surrounding the endosperm easily ruptured, and decay at the on set of the germination. Non-photosynthetic cotyledonary sheath elongate pushing the shoot apex into the soil up to about 4.6cm (Plate Va). This is in accordance to the work of Tomlinson (1961), Corner (1966) and Whitmore (1977), who reported that the fibrous shell of a palm seed endocarp rupture easily and this may be decaying at the time of germination. Gartin (1912), according to Tomlinson (1961) called it depreparation germination. After the growth of Cotyledon ceased, at about 47cm deep, the non-green plumule is exerted by piercing the Cotyledonary sheath and growth of the radicle commences (Plate V b).Ginies (1951), as reported Tomlinson (1961) called this stage of germination, degermination popre. Similarly, Gartin (1912), according to Tomlinson (1961) called it germination remotive with a ligulate structure, due to elongation of the cotyledon. In *Hyphaene,* cotyledon stalk is buried to a greater depth. This feature enables it to survive in a more desert environment than the other three palms under this study.

The First foliage leaf is simple, obovate and lanceolate tapering at the tip. Seedling remains attached to the seed. Adventitious root and root hairs become more established. Top brownish root is about 93cm deep. (Plate V c). This is in accordance to the findings of Tomlinson (1961), that first foliage leaf is simple and lanceolate. Similarly, seedling remained attached to the seed, this according to Ginies (1951), as reported Tomlinson (1961), so that food reserve from the endosperm is transmitted to it.

Leaves become large, and taproot is about 137.5cm (1.4 meters) forming a fibrous root system. Young whitish stem of about 14cm long develops. (Plate Vd).

Stem commenced upward growth, adventitious roots formed at the base of the seedling's stem. Thus, Stem enlarges and more leaves are formed. It has also been observed that subsequent leaves are of increasing height than the first ones. Leaves are V shaped as in *Phoenix* and *Borassus* (Plates V e and f). This corresponds to the work of Tomlinson (1961), Corner (1966) and Whitmore (1977) who called this type of development Corponicia, and reported that later leaves are larger and deeply segmented. This type of root system was also found in palms by Tomlinson (1961) i.e erect roots are produced at the base of many palms under appropriate condition.

5.2.3 Phoenix.

The thin stone ruptured, and the cotyledonary sheath extends so that the embryo is exerted from the seed. Elongation of the cotyledon is slight about 3cm

long. It is still attached to the seed. (Plate VI a). This according to Tomlinson (1961), is similar to the work of Gartin (1912) who called the exertion of the embryo from the seed "depreparation germination". He called the slight elongation of the cotyledon with a short cotyledonary ligule " germination remotive". Likewise, Ginies (1951) as reported by Tomlinson (1961) found out that food reserve is transmitted to the seedling from the endosperm of the seed; hence it remained attached to the seed.

Growth of the Cotyledon ceases and a photosynthetic plumule is exerted by piercing to cotyledonary sheath. Adventitious roots begin to develop from the radicle and buried to a depth of 11.3cm long (Plate VI b). this, according to Tomlinson (1961) corresponds to the work of Ginies (1951), who called it degermination popre stage of germination.

Stem begins to develop with adventitious roots being formed. The first foliage leaf with a digitate Lamina and undivided pleated blades become evident. Taproot is about 13cm long (Plate VI c).

Second Photosynthetic foliage leaf with a developing stem. Tap root and root hairs formed and buried to about 24.7cm deep (Plate VI d). Third leaf with digitate lamina and pinnate arrangement appeared. Fibrous root system becomes established and root is about 28.4 cm deep into the soil (Plate VI e).

At the fourth leaf stage, stem becomes more established. Adventitious roots with root hairs become evident. It is about 49.7 cm deep. Leaves increase in size, segment and complexity. They are V -shaped as *Borassus* and *Phoenix*

(Plate VI f). this according to the work of Tomlinson (1961), Corner (1966), Whitmore (1977) who reported that the first leaves have undivided pleated blades, and later developed one's are of increasing size and complexity. Similarly, first foliage leaf is succeeded by pinnate leaf arrangement as in *Nypha, Lodoicea, Elaeis* e.t.c.

5.2.4. Raphia

The Cotyledon elongates into the soil up to 24.3cm deep. The plumule emerges as a brownish structure independent of the cotyledon stalk. This is contrary to what is obtainable in other three Palms under study. No signs of root (Plate VII a). This as reported by Tomlinson (1961), is not in accordance to the work of Cook (1917) and Purseglove (1974) who reported that a massive stem apex is buried to a depth of up to 1 meter below the soil.

The plumule gradually turns green and compound foliage leaves emerged piercing it. Taproot developing with branch root and root hairs buried to a depth of about 28 cm into the soil (Plate VII b).

Foliage leaves are bifid, inverted ^ - shaped (as in *cocos, Elaeis* etc) and fully photosynthetic with a pair of opposite terminal leaflet. The stem is fully taking shape with points for new leaves to emerge. Roots are becoming complex and established up to a depth of about 29.9cm long (Plate VII c). Similar work was reported by Tomlinson (1961), Corner (1966) and Whitmore (1977), who found out that first foliage leaf is simple, lanceolate and is succeeded by pinnate leaves arrangement (as in *Roystenia, Lodoicea, Cocos* e.t.c) with at first, a few leaflets

inserted below a simple terminal leaflet. First foliage leaves are compound. Similarly Tomlinson (1961) reported that this type of root system was described by Cook (1941) as Rhizotyle.

Germination in Savanna palm could be referred to as " cryptogeal germination" by virtue of the fact that, the immature plumule is carried in to the soil, before the plumule and the radicle development takes place. This is similar to the findings of Jackson (1968) where he observed that, germination of *Botyrospermum paraxodum* seed is such that the apparent radicle carries the undeveloped plumule below the ground before plumule and radicle development takes place. He called this type of germination "cryptogeal".

There is obvious advantage to the Palm seedlings in this germination method, because they can firmly anchored into the ground, decreasing chances of desiccation Opeke (1982), and enabling the seedling to absorb leached nutrients, moisture, store and conduct it round their body Katherine, (1977).

5.3. SUMMARY

Two hundred and eighty seeds each of the four different Savanna Palms species (*Borassus, Hypaene, Phoenix* and *Raphia*) of approximate same age and size were collected from around the Northern Savanna. They were divided into eight groups of fourty seeds each, and subjected to thirteen different treatments, with the untreated serving as the control. Twenty seeds were planted per treatment. Probably, due to unsuitable weather and environment, only six seeds germinated for *Raphia sudanica*.

Result of analysis of variance for all the species and treatments, indicated that average days for germination, percentage germination, and average height were highly significant (P> 0.05).

The mean performance for days for germination indicated that chemical treatment significantly affected *Hyphaene thebaica*, followed by *Borassus aethiopum*, with no germination in *phoenix reclinata* and *Raphia sudanica*. Treatments soaked in water for two, four and six days with and without hole and placed in sawdust, treatment soaked in water for four days with hole, and treatment soaked in water for two, four and six days without hole significantly affected all the species. However, treated seeds of *Phoenix reclinatta*, germinated earlier, one to two months, *Hyphaene thebaica* two to three months, *Borassus aethiopum* 6 months to one year, and *Raphia sudanica*; two to four months. This shows significant difference compared to the control. Percentage germination indicated that treatments soaked in water for two, four and six days with and without hole, had significantly affected all the species. However, there was no significant difference between these treatments in *Borassus aethiopum* compared to the control. Average height, indicated that treatments soaked in water for two, four and six days with and without hole and placed in sawdust, and soaked in water for two, four and six days with and without hole, significantly affected height in *Borassus aethiopum*, *Hyphaene thebaica*, and *Phoenix reclinata*.

5.4. CONCLUSION

From this study, we were able to come out with simple ways of raising Palm trees for use in both schools and Public gardens. This will enhance the availability of Palm Seedlings for reafforestation practices. Likewise, it has provided literature on the Savanna Palm germination and Seedling characteristics. Consequently, teachers and students of Biology would become acquainted with these Savanna Palm trees, hence stimulating their interest into their research and study.

5.5. RECOMMENDATIONS.

1. All the treatments had significant effects on the parameters tested / studied among the species of the Savanna Palms, except in *Borassus aethiopum* where treatments had no significant effects on the percentage germination compared to the untreated (control).
2. Studies should be carried out on the appropriate skills for the collection, processing, and storage of Savanna Palm Seeds.
3. There is the need to carry out research on the Savanna Palm's Pests and diseases, as well as on the need to change to new and more productive

varieties, this may lead to an intensive evaluation of the savanna Palm genera.

4. Reafforestation practices should include the savanna Palm trees. This is to save them from being threatened with extinction, thereby increasing their population.

5. Annual grass fires, exploitation of the savanna Palm resources, and sap tapping should be minimized to the minimum by imposing tax, heavy fines, permits, restricting collection only from diseased and poor yielding trees and substituting tapped or failed tree with a new one. These, would save the great source of food and raw materials, hence boosting the economy of the farmer/ gardener and that of the country.

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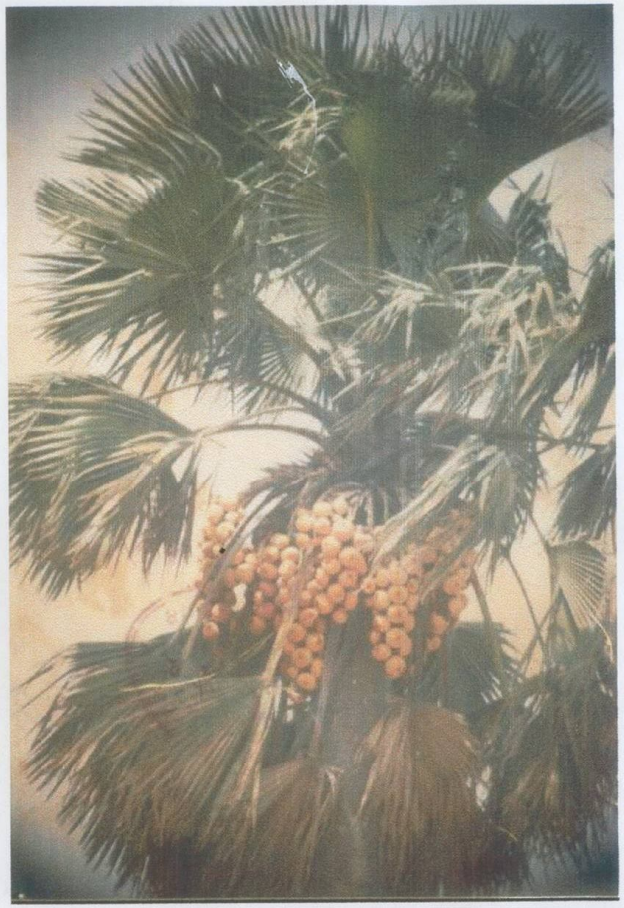
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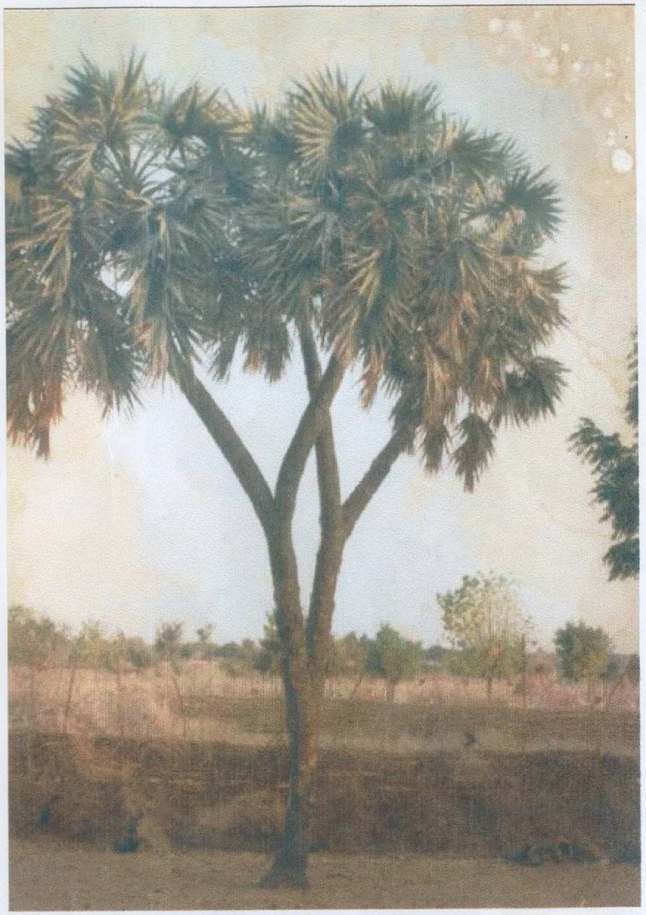
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(A) Borassus aethiopum
Snapped in April 2001, in Samaru

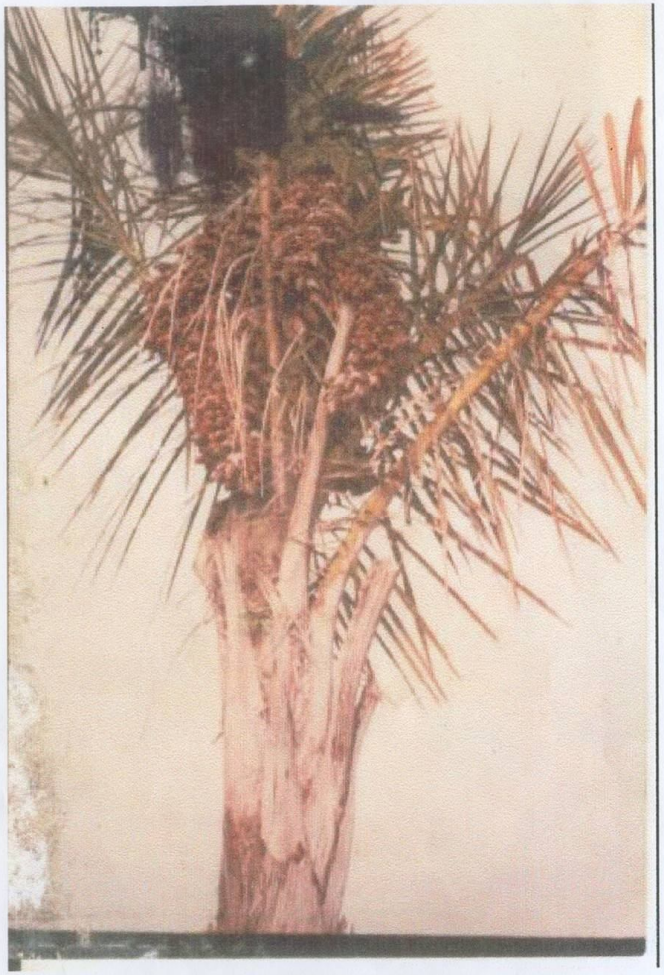


(B) Hyphaene thebaica
Snapped in March 2001, in Mani, Katsina

PLATE i: Showing the tree of Borassus and Hyphaene



(A) Phoenix reclinata
Snapped in April 2001, in Dakace, Zaria



(B) Raphia sudanica
Snapped in Feb. 2001, in Kauru

PLATE ii: Showing the trees of Phoenix and Raphia

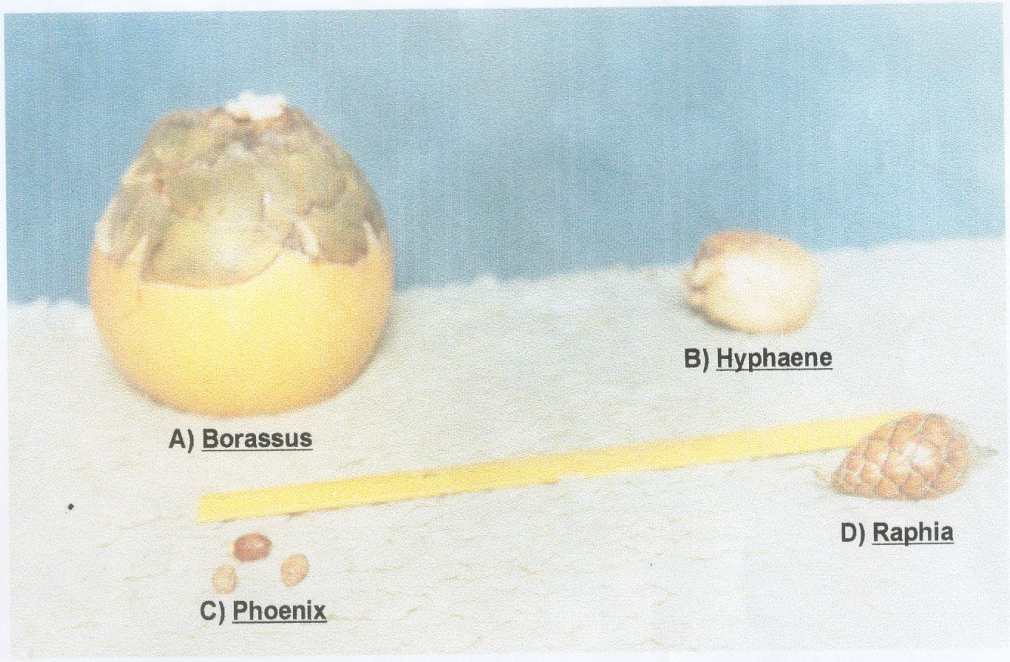


Plate iii: showing the four savanna palm fruits with a 12Inch Ruler Background



A) 8 Weeks after planting



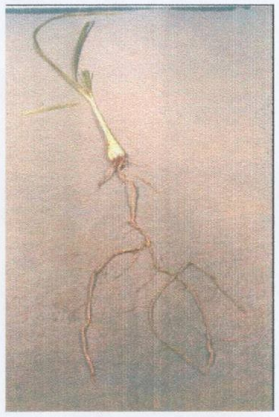
B) 12 WKS after PLANTING



C) 54 Weeks Old



D) 58 Weeks Old



E) 68 Weeks Old

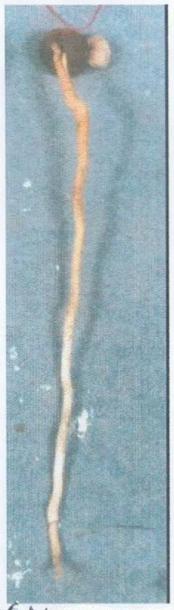


F) 72 Weeks Old

PLATE IV Showing the stages of germination and seedling characteristics in Borassus



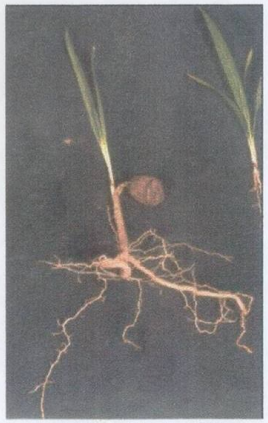
A) 27 days after planting



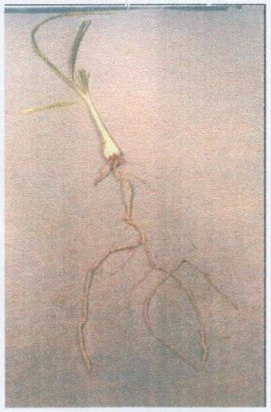
B) 16 WEEKS AFTER PLANTING



C) 21 Weeks Old



D) 29 Weeks Old



E) 52 Weeks Old

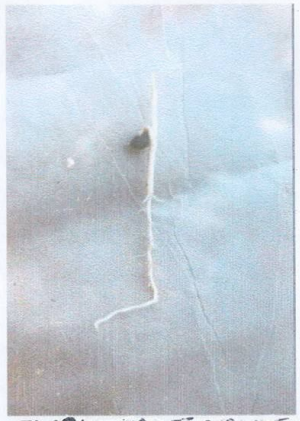


F) 54 Weeks Old

PLATE v: Showing the stages of germination and seedling characteristics of Hypaene



A) 2 Weeks after planting



B) 10 WEEKS AFTER PLANTING



C) 15 weeks old



D) 19 Weeks old



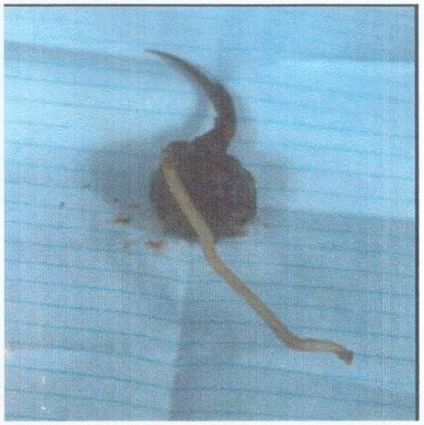
E) 22 Weeks old



F) 25 Weeks old

PLATE vi: showing the stages of germination and seedling characteristics in Phoenix

67 72



(A) 5 WKS after PLANTING



B) 7 Weeks Old



C) 10 Weeks Old

PLATE VII: Showing stages of germination and seedling characteristics in Raphia

CLASSIFICATION OF THE SAVANNA PALM TREES UNDER STUDY

Kingdom:		Plantae	
Division:		Spermatophyta	
Phylum:		Tracheophyta	
Sub – phylum:		Pteropsida	
Class:		Angiospermae	
Sub – class:		Monocotyledonae	
Order:		Palmales	
Family:		Palmae	
Genus:	1.	*Borassus*	
	2.	*Hyphaene*	
	3.	*Phoenix*	
	4.	*Raphia*	
Specie	1.	*Borassus*	*aethiopum*
	2.	*Hyphaene*	*thebaica*
	3.	*Phoenix*	*reclinata*
	4.	*Raphia*	*sudanica*

Source: Gill, L.S (1988).

Table I: Mean Squares of *Borassus aethiopum*

Source:	DF.	Average days-for germination proper	Percentage-germination	Average. height
Between treatments	11.	8822.92*+	1.99**	1151.89**
Within treatments.	22	2195.23	.83	690.21

Table III: Mean Squares of *Hyphene thebaica*.

Source:	DF.	Average days-for germination proper	Percentage-germination	Average-height
Between treatments	13.	1143.60*+	2.83**	677.38**
Within treatments.	13	315.45	1.45	196.85

*,** Significant at 5% and 1% levels respectively.

Table V. Mean Squares of *Phoenix reclinata*

Source:	DF.	Average days-for germination proper	Percentage-germination	Average-height
Between treatments	12.	210.74**	3.01**	120.73**
Within treatments.	38	96.05	1.12	139.34

*,** Significant at 5% and 1% levels respectively.

RAW DATA FOR BORASSUS AETHIOPUM

NO	TREATMENT	PLANTING DATE	DAYS OF PROPER GERMINATION	PERCENTAGE GERMINATION	AVERAGE HEIGHT AT 12 MONTHS.
1	Soaked in water for two days with hole	16-06-01	352	16 Seedlings 80%	14th /05/2003 12 months 78.2 cm
2	Soaked in water for four days with hole.	16-07-01	256	15 Seedlings 75%	16th /02/2003 1 months 86.6 cm
3	Soaked in water for six days with hole.	18-07-01	348	16 Seedlings 80%	13th /06/2003 12 months 67.23cm
4	Soaked in water for two days without hole.	29-05-01	382	16 Seedlings 80%	25th /05/2003 12 months 65.4 cm
5	Soaked in water for four days without hole.	01-06-01	391	16 Seedlings 80%	26th /05/2003 13 months 92.7 cm
6	Soaked in water for six days without hole.	03-06-01	356	10 Seedlings 50%	26th /05/2003 13 months 71.8cm
7	Soaked in water for two days with hole and put in sawdust.	03-08-01	269	-	14th /06/2003 12 months 87.50 cm
8	Soaked in water for four days with hole and put in sawdust.	05-08-01	-	-	-
9	Soaked in water for six days with hole and put in sawdust.	14-08-01	260	2 Seedlings 10%	02/05/2003 12 months 17.60 cm
10	Soaked in water for two days without hole and put in sawdust.	05-06-01	353	4 Seedlings 20%	04/05/2002 12 months 115.70 cm
11	Soaked in water for four days without hole and put in sawdust.	07-06-01	-	-	-
12	Soaked in water for six days without hole and put in sawdust.	09-06-01	342	2 Seedlings 10%	01/06/2003 12 months 45.82 cm
13	Soaked in Sulphuric acid for thirty minutes.	20-02-02	162	3 Seedlings 15%	16/02/2003 12 months 45.68 cm
14	CONTROL	17-05-01	371	16 Seedlings 80%	3oth /04/2003 12 months 45.83 cm

RAW DATA FOR HYPHAENE THEBAICA

NO	TREATMENT	PLANTING DATE	DAYS OF PROPER GERMINATION	PERCENTAGE GERMINATION	AVERAGE HEIGHT AT 14 MONTHS
1	Soaked in water for two days with hole	25-04-01	112	19 Seedlings 95%	26th /07/02 15 months 16 cm
2	Soaked in water for four days with hole.	27-04-01	98	17 Seedlings 60%	26/07/02 15 months 39.5 cm
3	Soaked in water for six days with hole.	29-04-01	97	12 Seedlings 60%	30/07/02 15 months 21.6 cm
4	Soaked in water for two days without hole.	27-04-01	88	20 Seedlings 100%	26/07/02 14 months 58 cm
5	Soaked in water for four days without hole.	29-04-01	99	16 Seedlings 80%	27/07/02 15 months 60.6 cm
6	Soaked in water for six days without hole.	01-05-01	90	13 Seedlings 65%	26/07/02 15 months 39.9 cm
7	Soaked in water for two days with hole and put in sawdust.	13-05-01	126	10 Seedlings 50%	21/07/02
8	Soaked in water for four days with hole and put in sawdust.	15-05-01	117	10 Seedlings 50%	21/07/02 14 months 38.4 cm
9	Soaked in water for six days with hole and put in sawdust.	19-05-01	126	14 Seedlings 10%	21/07/02 14 months 35.7 cm
10	Soaked in water for two days without hole and put in sawdust.	13-05-01	81	11 Seedlings 55%	20/09/02 15 months 21.23 cm
11	Soaked in water for four days without hole and put in sawdust.	17-05-01	103	15 Seedlings 75%	22/08/02 15 months 24.6 cm
12	Soaked in water for six days without hole and put in sawdust.	19-05-01	150	14 Seedlings 70%	15/08/02 15 months 46.9 cm
13	Soaked in Sulphuric acid for thirty minutes.	02-02-02	70	16 Seedlings 80%	18/04/03 15 months 22.2 cm
14	CONTROL	24-04-01	95	19 Seedlings 95%	21/06/02 14 months 55.4 cm

RAW DATA FOR PHOENIX RECLINATA

NO	TREATMENT	PLANTING DATE	DAYS OF PROPER GERMINATION	PERCENTAGE GERMINATION	AVERAGE HEIGHT AT 14 MONTHS
1	Soaked in water for two days with hole	15-05-01	48	18 Seedlings 90%	05/07/02 15 months 34.8 cm
2	Soaked in water for four days with hole.	17-05-01	46	17 Seedlings 85%	05/07/02 15 months 34.8 cm
3	Soaked in water for six days with hole.	19-05-01	44	14 Seedlings 60%	05/07/02 15 months 37.4 cm
4	Soaked in water for two days without hole.	24-04-01	50	20 Seedlings 100%	03/07/02 15 months 24.6 cm
5	Soaked in water for four days without hole.	27-04-01	59	15 Seedlings 75%	26/07/02 15 months 26.4 cm
6	Soaked in water for six days without hole.	29-04-01	44	14 Seedlings 70%	12/06/02 14 months 23.3 cm
7	Soaked in water for two days with hole and put in sawdust.	15-05-01	35	18 Seedlings 70%	07/06/02 14 months 25.7 cm
8	Soaked in water for four days with hole and put in sawdust.	17-05-01	54	17 Seedlings 85%	02/06/02 13 months 21.33 cm
9	Soaked in water for six days with hole and put in sawdust.	19-05-01	45	14 Seedlings 70%	11/06/02 13 months 32.53 cm
10	Soaked in water for two days without hole and put in sawdust.	11-05-01	37	19 Seedlings 95%	09/07/02 14 months 36 cm
11	Soaked in water for four days without hole and put in sawdust.	13-05-01	35	10 Seedlings 95%	28/06/02 13 months 36 cm
12	Soaked in water for six days without hole and put in sawdust.	15-05-01	38	19 Seedlings 95%	05/08/02 15 months 36 cm
13	Soaked in Sulphuric acid for thirty minutes.	02-02-02	-	-	-
14	CONTROL	24-04-01	47	17 Seedlings 85%	08/06/02 14 months 26.53 cm