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Influence of seed treatment and moisture content on germination and early growth of *Chrysophylum albidum* (G. Don)

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ABSTRACT

The *Chrysophylum albdum* is a low land rainforest tree that belongs to the family Sapotaceae, and frequently found in many eco-zones of West Africa, Nigeria inclusive. The African star apple features prominently in agroforestry-system for fruit, food, cash income and other auxiliary uses including environmental purposes. The aim of this study was to investigate the possible influence of seed treatment and moisture content on the germination and early growth of *C. albidum*. The seeds were extracted and subjected to different treatments (T1=seed own flesh, T2=seeds soaked in water for 8 days, T3=seeds soaked in hot water 100°C for 1 hr, T4=seeds cracked and soaked in water overnight, T5=seeds soaked in water for 10 days, T6=seeds soaked in water for 12 days, T7=seeds cracked and sown). These treatments were replicated three times and were laid in a Completely Randomized Design (CRD). Variables assessed were moisture content, germination percentage, plant height, collar diameter and leaf production for 12 weeks. The data collected were subjected to analysis of variance. The result of the ANOVA showed no significant differences at 5% level of probability for collar diameter while the leaf production and plant height shown significant differences among treatments at 5% level of probability. The moisture content show that M1 (moisture content for first week) has the highest germination of 26.6%, and the best performance was recorded in the seedlings raised with T2 in plant height, collar diameter and leaves production with a mean value 11.88 cm, 0.43 mm, 2.67 and germination with the value 66.7% respectively. It is recommended that seed of *C. albidum* should be soaked in water for 8 days before planting to enhance fast germination. And moisture content for the first week (18.8) is recommended for suitable seeds storage conditions for *C. albidum*.

Keywords: *C. albidum*; Moisture content; Seed germination; Early growth

INTRODUCTION

Chrysophylum albdum (G. Don) formerly known as *Gambeya albida* (G. Don) commonly called African star apple is a low land rainforest tree that belongs to the family Sapotaceae, and frequently found in many eco-zones of West Africa, Nigeria inclusive. It is locally called Udara and-Agbalumo in Igbo and Yoruba respectively and commonly called African star apple. The distribution is rare in Savanna or most of the Northern zones of Nigeria hence its name in Hausa language is unpopular (Keay, 1989).

The African star apple features prominently in agroforestry-system for fruit, food, cash income and other auxiliary uses including environmental purposes (Kang, 1992). It is found in villages and market squares, and home gardens. *C. albidum* fruits (known as African star apple) are widely eaten in southern Nigeria. The fruit is seasonal is usually December-March, the fruits is pointed at the apex, and up to 6 cm long and 5 cm in diameter. The peel is orange to golden yellow when ripe and the pulp within the peel may be orange, pinkish, or light yellow, within the pulp are three to five seeds which are not usually eaten. The seed-coats are hard, bony, shiny, and dark brown, and when broken reveal white-coloured cotyledons. This is' for medicinal purpose including the leaves and fruits.

The plant has in recent times become a crop of commercial value in Nigeria. The fleshy pulp of the fruit is eaten especially as snack and relished by both young and old (CENRAD, 1999). The fruit has been found to have the

highest content of ascorbic acid with 1000 µg to 3353 µg of ascorbic acid per l00 g of edible fruit 100 times that of oranges and 10 times of that of guava or cashew (Akubugwo et al. 2007). It has been observed that the tree of *C. albidum* has an efficient nutrient cycling ability, been an evergreen tree that rarely sheds all it leaves in any one season except when it is dead or under stress. The high rate of mineralization of the leaves improves the quality of the topsoil, and on sloppy terrain of compound farm *C. albidum* greatly checks the menace of soil erosion through its root anchorage and binding of soil particles. The tree equally provides shade for domestic animals within the compound farm system (Aduradola, 2005). It is important that an excellent source of vitamins, iron, and flavours to diets and raw material to some manufacture industries (Unelo, 1997) in additional its seed are source of oil, which is used for diverse purpose. The seed are also used for local game (Bada, 1997). *C. albidum* is not only the well know ingenious fruit tree but it is also among the known multipurpose forest tree species as the wood of the matured tree is converted for utilization purpose in construction of house and hut. In certain studies the wood is used for in household article and tool handles.

C. albidum seed have hard protective seed coat, inside the hard seed coat; the endosperm is also covered with wax-like layer which makes it difficult for seed to imbibe water for germination to state (Boateng et al., 2006). The character of the seed is a major reason for it dormancy leading to uneven germination which is a major setback in reforestation programme using *C. albidum* seed.

Soaking seed before planting is something to initiate the germination process and to shorten the time required for seedling to emerge from the soil. Such a treatment may be advantageous with seed normally slow to germinate with seed which are hard and dry, or when certain dormancy condition exit (Hartmann et al., 1990). According to Hartmann (1990) prolong soaking can result in injury to the seed and reduce germination. This harmful effect has been attributed principally to the presence of microorganisms and to poor aeration.

Mechanical pre-treatment such as removal of the seed coat are known to induce faster rate of seed germination than when seed coat is not scarification of *C. albidium* seed near the embryo before sowing showed significantly higher germination percentage of 88.9%.

There have been few studies to critically evaluate the appropriate the silvicultural significant on many tropical agroforestry species and the factors of importance in germination. It is necessary to initiate this study aimed at getting information nursery requirement for propagation of *C. albidum* and their below ground growth attributes. Knowledge on an individual tree below ground growth attributes is very important in ensuring successful establishment of the plantation and their inherent ecosystem services. Therefore, this study was carried out to investigate the influence of seed treatment on the germination and early growth of *C. albidum*.

MATERIALS AND METHODS

The experiment was carried out at the screen house of Federal College of Forestry, Ibadan. The College is located at Jericho area of Ibadan North West Local Government area of Oyo State, The area is on latitude 7°26’ N and longitude 3°15'E of the Greenwich meridian. Its annual rainfall is about 1400-1500 mm while annual mean temperature is 26.46°C. The average relative humidity is 80%-85% (FRIN, 2015).

The soil for the experiment was collected from the College farm, within the premises of the Federal College of Forestry, Ibadan. The collected soil was air-dried under shade (2 cm thickness) for three days. Afterwards, passed through a 2 mm-mesh sieve to remove foreign matter. A sub-sample was bagged and labelled to be taken to the laboratory for routine soil analysis (Table 1). The rest of the soil was filled into the germination baskets.

Table 1. Laboratory Analysis of the soil used for the experiment (FRIN, 2015).

Parameter	Soil
Ph (H_2O)	6.33
OC%	1.08
OM%	1.86
N%	0.09
SAND%	82.50
CLAY%	11.00
SILT%	6.50
P (mg/kg)	23.10
Ca (mol/kg)	7.60
Mg (mol/kg)	0.40
Na (mol/kg)	0.50
Cu (mg/kg)	2.70
Zn (mg/kg)	52.50
Fe (mg/kg)	425.00

The experiment was carried out in two phases namely:

Firstly, the investigation of seed germination and seedling growth rate under different seed treatments in the nursery. The seeds of *C. albidum* were extracted and different treatments were carried out which were T1 (seeds sown fresh), the seed were washed with water, T2 (seeds soaked in water 23°C for 8 days), the seeds were soaked in water for 8 days in order to break the dormancy, T3 (seeds soaked in hot water l00°C for 1 hr), the seed were soaked in hot water for l hr in order to break the seed dormancy, T4

(seeds cracked and soaked in water 23°C overnight), the seed was cracked manually using hammer to break the hard seed coat before it was soaked in water over night, T5 (seeds soaked in water 23°C for 10 days), the seed were soaked in water for l0 days in other to break the dormancy, T6 (seeds soaked in water 23°C for l2 days), the seeds were soaked in water for l2 days in order to break the dormancy, T7 (seeds cracked and sown), the seeds were cracked through the use of hammer to break the seed coat and sown.

Secondly, the determination of seed moisture content in the laboratory; *C. albidum* seed were extracted from the fruits, rinsed with water to remove all the pulp, cleaned and stored in a basket. The seeds were taken from the seed lot for moisture content determination, using the method of Olomu (1995). By drying seeds in an oven for 24 hrs at 75°C until constant weight was attained. The loss in weight was taken as the moisture content expressed as the percentage of the initial seed lot. After which the seeds was -sown to test for germination.

Seed Germination

The seeds of *C. albidum* sown into germination tray filled with top soil and watered daily to keep the soil moist but not drenched. Germination started in about 17 days after sowing.

Experimental Design

The experiment was laid out in a Completely Randomized Design (CRD). The treatments are as follows:

T1=Seeds sown fresh (control)

T2=Seeds soaked in cold water (23°C) for 8 days

T3=Seeds soaked in hot water (100°C) for 1 hr

T4=Seeds cracked and soaked in cold water (23°C) overnight

T5=Seeds soaked in cold water (23°C) for 10 days

T6=Seeds soaked in cold water for (23°C) 12 days

T7=Seeds cracked and sown

For Moisture Content

M1=moisture content for the first week

M2=moisture content for second weeks

M3=moisture content for second weeks

M3=moisture content for third weeks

M4=moisture content for fourth weeks

M5=moisture content for fifth weeks

Data Collection

The following parameters were assessed on weekly basis;

Germination Percentage (%)=No of germinated seed/Total no of seeds sown X 100, (Copeland and McDonald, 1999).

Plant Height (cm); Measured from soil surface to the tip of the plant, with the use of measuring ruler.

Seed Moisture content; by drying seeds in an oven for 24 hrs at 75°C until constant weight was attained.

Collar Diameter (mm); measured with the use of Vernier caliper.

Leaf Production; Number of leaves per plant was counted.

Data Analysis

Data collected were then subjected to one-way analysis of variance to compare the effect of the different treatments on the early growth characteristics *C. albidum* seedlings. The mean were separated using Duncan Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

Percentage Germination

From Table 2, shows the degree of variation of *C. albidum* seeds under different treatments. There was a steady increase in the germination of the seeds from l8 to 28 days, the result of seeds soaked in water is inversely proportional to that of seed cracked. T2 performed best with the value 66.7%, followed by T5 with the value 44.4%, while T7 has the least performance with the value 14.4% (Tables 3 & 4).

Table 2. Analysis of Variance (ANOVA) for Height, Stem Diameter and leaf production.

		Height	Collar diameter	Leaf production
Sources of Variation	**Df**	**p-Value**	**p-Value**	**p-Value**
Treatment	6	0.001^{*}	0.060^{ns}	0.000^{*}
Error	14			
Total	20			
*=significantly different, ^{ns}=not significantly different				

Seedling Height

ANOVA results (Table 2), for seedling height indicated significant differences ($p \leq 0.05$) across the assessment period of 2 to 12 weeks among the treatments. However, the result shows that from Week 2, T2 has a mean height of 5.66 cm, followed by T5 which has a mean value of 5.20, T2 has the least value at week 2, there was a steady increase in the seedlings height for all the treatments, T2 had the best performance in the height with the mean value of l1.88 cm fo1lowed by T5 with mean value of l0.64 cm,

while the ‘least was observed in T7 with the value of 6.00 cm (Table 5).

Table 3. Germination of *C. albidum* seeds from various treatments.

Treatment	Days After Sowing (DAS)					
	18	20	22	24	26	28
T1	5.00	12.00	20.00	27.00	30.00	32.00
T2	17.00	22.00	30.00	39.00	43.00	60.00
T3	4.00	10.00	18.00	29.00	32.00	34.00
T4	2.00	7.00	9.00	10.00	13.00	15.00
T5	10.00	15.00	20.00	28.00	35.00	45.00
T6	11.00	18.00	20.00	26.00	32.00	40.00
T7	3.00	8.00	10.00	11.00	12.00	13.00

Table 4. Percentage germination of *C. albidum* seeds from various treatments.

Treatments	Number of seeds Sown	Number of seeds Germinated	Germination percentage (%)
T1	90	32	35.6
T2	90	60	66.7
T3	90	34	37.8
T4	90	15	16.7
T5	90	45	50.0
T6	90	40	44.4
T7	90	13	14.4

Table 5. Mean Plant Height (cm) of *C. albidum* seedlings after 12 week.

Assessment period (weeks)	T1	T2	T3	T4	T5	T6	T7
2	2.06	5.66	4.33	2.30	5.20	3.33	2.00
4	4.30	8.66	7.33	4.30	8.00	5.00	2.30
6	6.00	11.33	10.33	7.00	10.66	7.00	5.30
8	8.70	14.00	10.33	7.60	12.33	9.00	7.00
10	11.30	15.66	12.33	9.30	13.66	10.66	8.33
12	11.60	16.00	13.00	10.00	14.00	11.00	8.60
Mean	7.41	11.00	9.60	6.75	10.64	7.67	6.00

Table 6. Mean Collar Diameter (mm) of *C. albidum* seedlings after 12 weeks.

Assessment period (weeks)	T1	T2	T3	T4	T5	T6	T7
2	0.10	0.10	0.10	0.10	0.10	0.10	0.10
4	0.20	0.30	0.20	0.20	0.20	0.30	0.30
6	0.40	0.40	0.40	0.30	0.20	0.40	0.30
8	0.50	060	0.50	0.30	0.30	0.60	0.30
10	0.50	0.60	0.50	0.40	0.30	0.60	0.30
12	0.50	0.60	0.50	0.40	0.30	0.60	0.40
Mean	0.37	0.43	0.37	0.28	0.23	0.43	0.28

Table 7. Mean leaf production of *C. albidum* Seedlings after 12 weeks.

Assessment period (weeks)	T1	T2	T3	T4	T5	T6	T7
2	2.0	2.0	2.0	2.0	3.0	2.0	2.0
4	2.0	3.0	2.0	2.0	2.0	2.0	2.0
6	2.0	2.0	2.0	2.0	2.0	2.0	2.0
8	2.0	2.0	3.0	2.0	3.0	3.0	3.0
10	2.0	2.0	3.0	3.0	3.0	3.0	3.0
12	2.0	2.0	3.0	3.0	3.0	3.0	3.0
Mean	2.0	2.2	2.5	2.3	2.7	2.5	2.5

Table 8. Moisture content of *C. albidum* seeds at different weeks.

Treatments	Moisture content	Number of seeds Sown	Number of seeds Germinated	Germination percentage (%)
M1	18.8	30	8.0	26.7
M2	14.0	30	6.0	20.0
M3	5.5	30	4.0	13.3
M4	9.6	30	5.0	16.7
M5	11.2	30	6.0	20.0

Seedling Collar Diameter

From Table 2 above, ANOVA result showed no significant differences ($p \leq 0.05$) for seedling collar diameter at the end of 12 weeks in all the treatments. Table 6 above, however observed that T2 and T6 had the highest value for

collar diameter each (0.43 mm), followed by T1 which has a mean value of and T3 with equal value of 0.36, while T5 had the least value of collar diameter (0.23).

Seedling Leaf Production

ANOVA result for leaf production indicated significant differences ($p \leq 0.05$) (Table 2) at the end of 12 weeks period of assessment. But, T2 performed best with respect to number of leaves at 6 weeks of sprouting with the highest mean value (2.67), while T1 and T4 had the least performance (2.33) as shown from Table 7.

Moisture Content

Results in Table 8, shows that at M1 with moisture content of 18.8 had a germination percentage of 26.6%, followed by M2 with a moisture content of 14.0 had a germination percentage of 20.0%, M4 and M5 with a moisture content of 9.6 had a germination percentage of 16.6% each, while the least germination percentage in M3 with a moisture content of 5.5 (13.3%).

DISCUSSION

Timing of germination of any seed is critical as the likelihood of seedling's survival is dependent upon the subsequent availability of adequate water, temperature, light and nutrient to support plant growth. Germination began earliest (18 DAS) and ended earliest (28 DAS) which closely related to Orwa et al., 2009 findings that germination of *C. albidum* commenced in 21 days. And T2 has the highest germination percentage (66.7%).The lowest germination value of 14.4% was observed in seeds cracked T7. The result showed that soaking of seeds for the 8 days improved germination and this was probably due to the increase in hydrolytic enzyme in the right proportion. This is in agreement with the work of Agele et al., 2016, who reported, that soaking of seeds in water increases germination percentage. It could be worthwhile to however investigate this treatment using other plant to determine their responses within 8 days of soaking. Germination was poor in T7, probably because the embryo may have been damage when cracked which might have inhibited embryo germinate well (Oboho et al., 2010), who observed the lowest germination percentage with decoated *C. albidum* and opined that seed coat removal was detrimental to *C. albidum* seed germination. Though, most tropical tree seeds have been reported to have inherent dormancy that might result in the delayed and uneven germination of seeds (Adekunle, 2010). This is however contrary to the work of Agboola et al., (1991) who noted that the removal of seed coat improve germination of Leucaena leucocephela. However, this study supports the earlier observation of Bonviutto and Busso (2007) that lack of moisture availability imposes severe limitation on seed germination of *C. albidum* which has similar germination requirements to that of many mesophytic crops. It can be said that the rest methods of treatments supported germination of *C. albidum* seeds, but soaked in water for 8 days is the best. This means a lot to regeneration of this important fruit tree which has been said to have poor natural regeneration (Orwa et al., 2009). It has been reported that farmers engage in the planting of the seedlings of *C. albidum* adopt propagation method such as transplanting of wildlings and retaining naturally germinated seedlings on farms. Planting of wildlings is said to be the predominant method (Orwa et al., 2009). However, this study has shown that *C. albidum* seedlings can be successfully raised in the nursery before eventual planting out by adopting appropriate silvical methods especially regarding application of soaked in water for 8 days.

Seedling growth variables indicated significant differences for the various methods of treatments at different times in the course of the assessment period. However, the fact that soaked in water for 8 days in comparison with other treatments consistently produced the highest value for all the growth variables (that is, seedling height, seedling collar diameter and leaf number) is an indication that soaked in water for 8 days is the best among other for early vegetative growth of *C. albidum* young plants.

The analysis of germination trends showed spreading over time with moisture content. The spreading of seed germination could be due to variability in dormancy depth as reported by Agele et al., 2016.The germination rates were quite low judging from the moisture content trend from the 1st week to the 5th week. The failure of seeds germination may be due to embryo death or deep seed dormancy. The high proportion of ungerminated seeds may be a consequence of a high proportion of dead seeds; however the poor seed quality may be correlated to seed moisture content as *C. albidum* seeds are sensitive to desiccation that usually decreases seed viability. It was revealed that the germination rate decreased with the seed moisture content and at 5.5 moisture content most seeds died and failed to germinate; the seed water content at harvest (18.8) allowed the best germination rate and the shortest spreading out of the germination period. Comparable results were obtained for *Garcinia kola*, a tropical recalcitrant seed (Orwa et al., 2009), which reported that dried, seeds used in the experiment were responsible for poor seed germination and growth spread. Further investigation will enable to assess more accurately how seed viability and dormancy depth vary according to the seed moisture content to determine the suitable seeds storage conditions.

CONCLUSION AND RECOMMENDATION

C. albidum exhibited hypogeal type of germination. The seed is recalcitrant and needs more effective pre-treatment. *C. albidum* seeds had poor germination which could be due to dormancy, poor seed quality or seed viability is affected by desiccation. Dormancy-breaking was improved by *C. albidum* seeds been soaked in water and it supported very good germination, and appreciable growth were still

obtained when seeds were soaked in water for 8 days. The germination rate was from 14.4%-66.7% and the germination time 18-28 days. The seeds soaked in water for 8 days had the best germination percentage and seeds cracked and sown had very poor germination. There was significant difference in height and leaf production, except in collar diameter in relation to seeds soaked in water for 8 days being the best for growth. But, Germination was affected negatively by cracked and sown seeds where quite a number of seeds failed to germinate. The seed water content at 18.8 allowed the best germination rate and the shortest spreading out of the germination period. It is recommended that seeds soaked in water for 8 days should be used on *C. albidum* for high germination and high seedling growth. And moisture content for the first week (18.8) is recommended for suitable seeds storage conditions.

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