Journal of Sustainable Development in Africa (Volume 22, No.1, 2020)
ISSN: 1520-5509
Clarion University of Pennsylvania, Clarion, Pennsylvania

EFFECTIVENESS OF MECHANICAL SCARIFICATION AND FERTILIZER TYPES ON SEED GERMINATION AND EARLY SEEDLING GROWTH OF *CHRYSOPHYLLUM ALBIDUM* G. DON

[1] Adeboyin Funmi Aderounmu [2] Israel Olatunji Asinwa and [1]Abayomi Ayodeji
[I] Federal College of Forestry, Ibadan. [2] Forestry Research Institute of Nigeria.

ABSTRACT

Chrysophyllum albidum is an important fruit tree species with peculiar hard seed coat and slow growth. This study investigated effectiveness of mechanical scarification on seed germination and fertilizer types on sustainable growth of *C. albidum* seedlings. Five batches of 50 seeds each were subjected to 5 mechanical scarification treatments. Uniform seedlings were subjected to NPK 15:15:15 and organo-mineral fertilizer treatments. The experiment was laid out in completely randomized design with 4 treatments replicated 3 times; T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control. There were significant differences among the treatments on the germination ($p<0.05$). On the growth assessment, T_3 gave the highest Shoot height (35.80cm) and leaf production (15). Highest collar diameter (0.87cm) and leaf area (13.40cm^2) were recorded for T_1. Mechanical scarification and growth media amendment with the use of organic and inorganic fertilizers catalyzed the growth of the species sustainably.

Keywords: Pre-Sowing Treatments, Organo-Mineral, Inorganic Fertilizer, Organic Fertilizer, Germination, Sustainable Growth

INTRODUCTION

Forests are vital sources of sustainable food, medicine, raw materials and income for millions of people. Non-wood product from forests, particularly the edible fruits, represented an important part of the rural economy which was hitherto under-estimated in many developing countries including Nigeria (FAO, 1997). Many communities in Nigeria have known how to make use of these fruits through the knowledge, which have been passed down for many generations (Obiefuna *et al.*, 2012). Majority of these indigenous fruits have been found to provide well nutritious (fortified with some important essential minerals) food or a refreshment to sustainably cover all seasons of the year. Such edible fruit producing trees include *Chrysophyllum albidum, Irvingia gabonensis, Dacryodes edulis, Tamarindus indica, Treculia africana* and so many others. All these trees produce their edible fruits in abundance at different time or season of the year (Wilson *et al.*, 2001; Sakin *et al.*, 2005, Agbo and Omalik, 2006)

Despite the menace of deforestation which has resulted in substantial loss of these indigenous fruits tree germplasm, the remaining few ones which are being conserved are now undergoing domestication processes to produce abundant fruit in their respective fruiting season in a sustainable manner (Sakin *et al.*, 2005). However, the joy of bountiful fruit harvest by individual farmer or forest dweller is short-lived due to improper management such as poor method of harvesting, careless post-harvest handling, poor transportation network, and marketing problems (Okafor, 1987). All these poor management especially over-exploitation, which hang on too many factors are causing large losses of fruits that require large inputs of labour, materials and many at times, capital (money), to grow and harvest (Jimenez, 1983). In fact, Almost 10 -50% post harvest loss in fruit production has been reported (FAO, 1997).

A successful germination for regeneration programmes is facilitated by sowing of viable seeds which will eventually become seedlings. Ikyaagba *et al.* (2018) stated that germination is a process by which the dormant embryo of the seed resumes active growth and forms a seedling. Generally, seed germination is enhanced by many factors such as the type of substrate used (Ikyaagba *et al.*, 2018), environmental factors such as oxygen, water, temperature and light. In some cases, despite the presence of these factors seed germination in tree species is sometimes difficult due to hard seed coat and dormant embryos and the seeds often fail to germinate (Hartmann *et al.*, 2007 and Dolor, 2011). To overcome this problem and ensure sustainably developed germination potentials, several methods including mechanical scarification, chemical scarification, soaking in cold and hot water are used for treating seeds prior to sowing (Salami and Lawal, 2018). For example, In the early days of silvicultural practice, seeds of desired forest species were normally broadcast or planted out as striplings, stumps and wildings collected under the natural forest canopy while fertility status of the soil was hardly taken into account (Olagunju and Ekwebelam, 1985). Consequently, heavy losses of seeds and seedlings were usually sustained, the cause which was later traced to soil-nutrient depletion (Fagbenro, and Aluko, 1987). The thought that the easiest way to replenish soil in the nursery is through application of fertilizers, gave rise to its usage in the history of sustainable forest nursery development in Nigeria in colonial days (Olagunju and Ekwebelam 1985). The effect of the application was observed to be very spontaneous, as a parcel of land which was initially created as make-shift or temporary nursery, was immediately converted to permanent nursery, where structures were erected to minimize seeds and seedling loss (Sakin *et al.*, 2005). All along, natural fertility of the soil in the nursery set-up, tree crops like other crops needs adequate supply of all the essential nutrients in order to sustainably grow, develop and produce good quality fruits and wood material. When nutrients are inadequate, growth is reduced and the quality of nursery stocks and harvested products become poor and unsustainable (Okafor, 1987).

Chrysophyllum albidum commonly called African Star Apple or White Star Apple is a low branched crown evergreen tree which can grow up to 40m tall. The buttressed based tree extends into flutting which can be up to 2m in diameter. It is a prominent indigenous, economic fruit tree species in the humid tropics and an important plant species in Nigeria which cannot be over-emphasized (Kafaru, 1994; Gbile, 1997). It has edible fruits which are usually gathered from the wild by local peoples who domesticate some stands as village fruit tree because of the economic benefit derivable from its sale in the local markets; reason why some of the mother trees are seen planted around villages. However, its successful domestication is retarded because of unavailability/scarcity of the seedlings due to its germination problem arising from hard seed coat dormancy; so most farmers find it difficult to germinate the seeds. The need to meet the present and future demand is to establish nursery and plantation operations that are the most important stages in growing *C. albidum* in order to ensure successful orchard establishment (Keay, 1989; Okunomo *et al.,* 2006). The growth of *C. albidum* can be enhanced through the use of appropriate fertilizer and its subsequent sustainable management is essential for profitable production and environmental sustainability. The key to the sustainable development and successful orchard establishment is to know the tree needs and matching fertilizer programme to those needs and rules to follow (Adelani and Mohammed, 2019). To achieve this, appropriate silvicultural knowledge in terms of dormancy breaking for high germination capacity and enhanced growth rate using ideal fertilizer sources required by seedlings in the nursery must be known. Therefore the success or failure of establishing African Star Apple orchard in Nigeria depends largely on the nursery technique adopted in raising the seedlings at nursery stage.

This has therefore necessitated the need to carry out this study on the pre-sowing treatments and early growth of *C. albidum* and how it can be improved by the addition of various fertilizers at the nursery stage and recommend accordingly for effective and better sustainable growth of the species.

MATERIALS AND METHOD

Study Area

The experiment was carried out in the screen house of Federal College of Forestry Jericho Ibadan, Oyo State. The area lies between longitude 07º 26' 15" N to 07º 25'46" N and latitude 03º 54' 22" E to 03º 53' 40" E of the greenwich meridian. The climatic pattern of the area is tropically dominated by annual rainfall range from 1300-1500m and average relative humidity of about 65%, the average temperature is about 26º C, the eco-climate of the dry season usually commencing from (November to March) and the raining season start from April to October (FRIN, 2018).

Fresh fruits of *Chrysophyllum albidum* were collected from its orchard in Forestry Research Institute of Nigeria under one of the mother trees with good traits and depulped for extraction of seeds. Extracted seeds were washed, air-dried and whole seed lot divided into five batches of 50 seeds each. One batch was intact and directly sown (T_1- control) while the other four (4) batches were subjected to four mechanical scarification processes (T_2- 2mm pointed end chipped off; T_3- seed coat thinly filed; T_4- seed coat gently cracked and T_5- shaken seed with sharp sand) before being sown inside germination trays filled with sterilized river sand and replicated three times and set under non-mist propagator chambers and watered daily. Germination was monitored and number of germinated seeds were counted and recorded until none was recorded in two consecutive days. The following germination analyses were carried out:

1. Germination Percentage (%) = $\frac{total\ seeds\ germinated}{Total\ sseds\ sown}$ X 100 ….….. (Eqn. 1.)
2. Mean Daily Germination percentage (MDG): This is cumulative total percentage of germinated seeds divided by exact germination day.

MDG(%)= $\frac{Cumulative\ Total\ Percentage\ of\ seed\ sown}{X}$ ……….. (Eqn. 2.)

Where: x = Exact germination day

3. Mean Germination Time (MGT) = $\frac{\Sigma nd}{N}$ ………(Eqn.3)

Where, n = number of germinated seed on each day; d = number of days from onset of the test; N = total number of germinated seeds;

4. Rate of Germination = Reciprocal of MGT = $\frac{1}{MGT}$ ………(Eqn. 4)

Polythene pots were filled with top soil and mixed with Organic manure from poultry droppings while NPK 15:15:15 and organo-mineral fertilizer were also prepared alongside in (g) using Part Per Million (PPM) method. Analyses of the poultry and organo-mineral fertilizer were done to know the nitrogen content.

Uniformly growing seedlings of *Chrysophyllum albidum* were transplanted into the polythene pots and various growth assessments commenced at the point of transplant (PT). Fertilizer treatments (2.1g NPK, 1.8g organo-mineral and 11.7g organic fertilizer per pot) were applied to the top soil medium. Organic manure was mixed with the top soil before being filled into the polythene pot..

Calculation for Fertilizer Quantity Per Pot (Sarrantonio, 1991)

For inorganic fertilizer

Using 100ppm of NPK 15:15:15

$$= \frac{\%\ Total}{\%\ of\ Nitrogen}\ x \frac{100}{Area\ of\ land}\ \ x\ Weight\ of\ Soil$$

$$= \frac{100}{15}\ x \frac{100}{1,000,000}\ \ x\ \ 1000\ (1kg)\ \ = 0.7\text{g}$$

For organo-mineral fertilizer

Using 100ppm of the Organo-mineral fertilizer

$$= \frac{100}{162} x \frac{100}{1,000,000} \ x \ 1000 \ (1kg) \ = 0.6g$$

For organic fertilizer

Using 100ppm

$$= \frac{100}{2.58} x \frac{100}{1,000,000} \ x \ 1000 \ (1kg) \ = 3.9g$$

The experiment was laid out in completely randomized design with four (4) treatments replicated three (3) times with five (5) seedlings in each replicate where T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control

Growth parameters such as shoot heights were measured from the root collar to apical bud using a graduated ruler in centimeter, leaf production were observed by counting number of leaves, collar diameters were measured at 2cm above the root collar with the use of digital caliper and leaf area using leaf area meter. Data collected were subjected analysis of variance (ANOVA).

RESULT AND DISCUSSION

Effects of different Mechanical Scarification on the germination of *C. albidum* seeds

Table 1 shows the result of the effects of different mechanical scarification methods on germination of C. albidum seeds. The Mean daily germination (MDG) shows that T_1 had highest value of 8.4 with Mean Germination Time (MGT) of 2.34. This was closely followed T_3 with the MDG of 3.9 and MGT of 4.46. The T_1 had the least value with MDG of 2.8 and Rate of Germination (RG) of 0.13 (Table 1).

Table 1: Germination values of *C. albidum* seeds under different mechanical scarification methods

TREATMENT	Mean Daily Germination MDG	Mean Germination Time (MGT)	Rate of Germination (RG)
T_1	2.8	7.84	0.13
T_2	8.4	2.34	0.43
T_3	3.9	4.46	0.22
T_4	3.2	5.65	0.18
T_5	3.1	6.65	0.15

Table 2 show that there are significant differences ($P \leq 0.05$) among the five treatments applied on seeds of *C. albidum.* This is an indication that pre- sowing treatments which seeds of *C. albidum* were subjected to had pronounced influence on germination. From table 3, it is shown that T_2 had the highest mean germination percentage (85.3 %) followed by T_3 (62.6%) while the least was recorded for the control treatment (T_1) with 50.0%. Figure 1 reveals that T_2 had the highest number of germinants from 7th day till 15th day with highest germination of (8 emergent) on the 11th day. The control treatment did not germinate until 13th days after sowing where it had the least value of one (1) germinants. This depicts that mechanical scarification influenced early germination of hard coated and recalcitrant seeds of *C. albidum*. This is in line with findings of Isah (2012) on *Parkia biglobosa*., Olujobi *et al.* (2009) on *Afzelia africana*, Morteza *et al*. (2011) on *Citrullus cococynthis*, Aduradola *et al.* (2005) on *Chrysophyllum albidum* that mechanical scarification enhances the sustainable germination and development of seeds of *C. albidum.*

Trend of Germination of *C. albidum* seeds subjected to various types of mechanical scarification is presented in Figure 2. All treatments except T_1 began to germinate on the 7th day with T_2 having the highest germination. The trend increased until 17th day when germination began to decrease. The earlier germination of seeds with mechanical scarification implies that the treatments eased penetration of moisture and gases into the seeds and enhanced development of embryo (Olujobi *et al.*, 2009). Breakdown of this layer by mechanical stresses leads to penetration of water and activation of embryos.

Table 2: ANOVA result for the effect of Mechanical Scarification on the percentage germination of *C. albidum* seeds

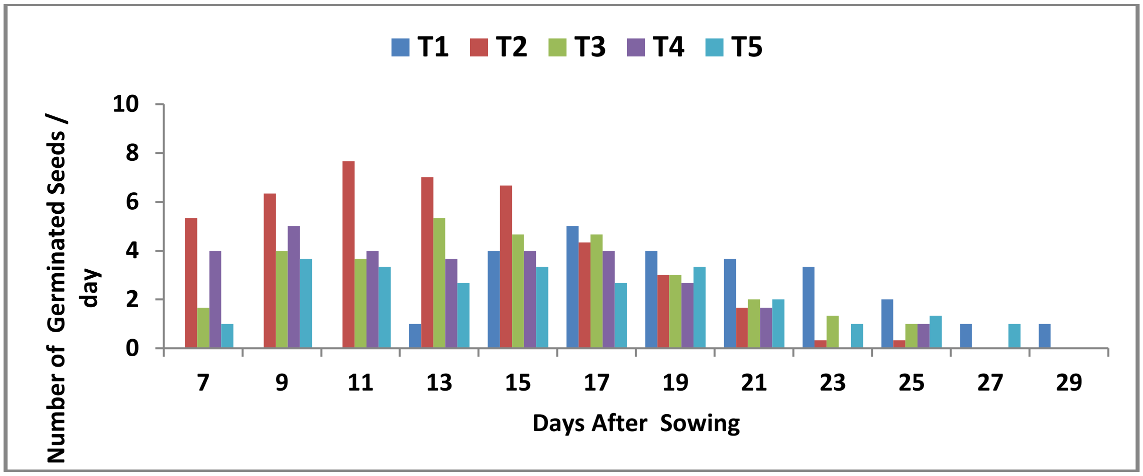
Source of Variation	df	Sum of Squares	Mean Square	F	Sig.
Types of Mechanical Scarification	4	2462.93	615.73	8.55	0.00*
Error	10	720.00	72.00		
Total	14	3182.93			

Significant (P<0.05)

Table 3: Effect of mechanical scarification on the percentage germination of *C. albium* seeds

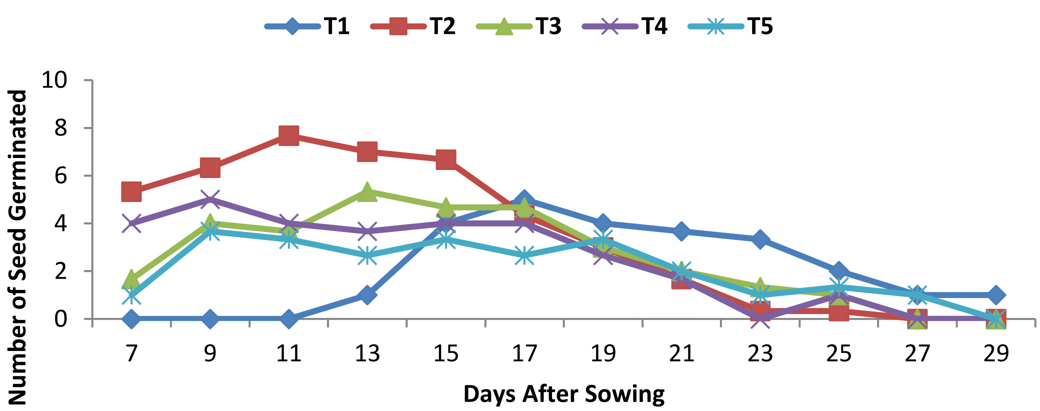
Types of Mechanical Scarification	Percentage Germination
T_1 (Fresh Intact Seeds- (control)	50.00±3.06a
T_2 (2mm Pointed end of Seed coat Chipped off	85.3±31.33b
T_3 (Thinly Filed Seed Coat)	62.6±77.69a
T_4 (Gently Cracked of Seed Coat)	60.0±04.16a
T_5 (Seeds Shaken With Sharp Sand)	50.67±5.5.70a

Means (n= 3) ± SE. Numbers followed by different letters (a–b) are significantly different at the level of P <0.05 according to DMRT.



Note: T_1 (Fresh Intact Seeds- (control), T2 (2mm Pointed end of Seed coat Chipped off), T_3 (Thinly Filed Seed Coat, T_4 (Gently Cracked of Seed Coat); T_5 (Seeds Shaken With Sharp Sand)

Figure 1: Effect of different Types of Mechanical Scarification on daily germination of *Chrysophyllum albidum* seeds



Note: T_1 (Fresh Intact Seeds- (control), T_2 (2mm Pointed end of Seed coat Chipped off), T_3 (Thinly Filed Seed Coat), T_4 (Gently Cracked of Seed Coat); T_5 (Seeds Shaken with Sharp Sand)

Figure 2: Trend of Germination of *Chrysophyllum albidum* seeds subjected to various types of mechanical scarification

Effects of organo-minerals, inorganic and organic fertilizers on the growth of *C. albidum* seedlings

Analysis of Variance (ANOVA) result of the effects of organo-minerals, inorganic and organic fertilizers on shoot height, collar diameter, leaf production and leaf area of *C. albidum* are presented in Table 4. Fertilizer sources and application improved early growth of *C. albidum* seedlings. However, there were no significant differences among the treatments on the growth variables assessed. This implies that the influence of the three types of fertilizers were more or less equal on the seedlings of *C. albidum* within period the of study. It has been found that nursery soil mixtures; mainly amended with organic and inorganic manure have been found to both influence the quality of seedlings produced (Wilson *et al.*, 2001; Sakin *et al.*, 2005, Agbo and Omalik, 2006, Obiefuna *et al.*, 2012). In the same vein, good production of permanent tree crop seedlings in the nursery phase is highly influenced by the potting mixture used (Sakin *et al.,* 2005; Adelani *et al*., 2014a). Agbo and Omaliko, (2006) stated that the performance of seedlings in the main field is determined by their performance in the nursery which therefore necessitated better understanding of the appropriate fertilizers needed for optimum and sustainable growth of *C. albidum*.

Table 4: Analysis of Variance (ANOVA) for Effectiveness of Organo-minerals, Inorganic and Organic fertilizers on Growth Variables of *Chrysophyllum albidum* seedlings

	SV	df	SS	MS	F-cal	P-Value
Shoot Height (cm)	Treatments	3	32.073	10.69	.080	.970^{ns}
	Errors	32	4270.69	133.46		
	Total	35	4302.76			
Collar Diameter (cm)	Treatments	3	0.024	0.008	0.178	.970^{ns}
	Errors	32	1.439	0.045		
	Total	35	1.463			
Leave production	Treatments	3	1.315	.438	0.64	.970^{ns}
	Errors	32	220.82	6.901		
	Total	35	222.136			
Leave area (cm^2)	Treatments	3	11.219	3.740	0.509	.970^{ns}
	Errors	32	234.965	7.343		
	Total	35	246.184			

ns = not significant at $P > 0.05$

Table 5 shows the effects of three types of fertilizers on mean shoot height (cm) of *C. albidum*. The organic fertilizers (T_3) gave the highest shoot heights from the 1st week (10.3cm) of reading till the 8th week of growth assessment (35.80cm) while the control treatment (T_4)had the least values (32.40cm) at the end of the 8th week. This is an indication that organic fertilizers enhanced the development of apical tissues a bit higher than others despite the fact there were no significant variation among the treatments. The higher performance of the *C. albidum* seedlings under the influence of organic fertilizer could be as a result of its essential qualities of better and steady supply of nutrient as well as improvement of physical, chemical and microbial properties of the soil. According to Belay *et al*; (2001), application of organic materials as fertilizers provides growth-regulating substances and improves the physical, chemical and microbial properties of the soil. Similar observations were made by Awodola (1991) on *Parkia biglobosa*; Adelani *et al.* (2014b) on *Chrysophyllum albidum*; Aina *et al*. (2012) on *Abelmoschus esculentus* and Iren *et al.* (2012) on *Telfairia occidentalis*. Moreover, studies of Okpara and Mbagwu (2003) and Iren *et al.* (2011) on ultisol soil have shown that organic fertilizer increases soil organic carbon content more than inorganic fertilizers. Aruleba and Fasina (2004) reported that organic fertilizer binds the soil together, absorbs water and release nutrients steadily for vegetable crops. This is in consonance with the reports of Okunomo *et al.* (2006) and Adelani and Mohammed, (2019) who reported that poultry droppings is the richest and most concentrated manure because urine and feaces are mixed together contributing to its high nitrogen and phosphorus content, and that poultry droppings fermented easily, releasing ammonia in the process.

Table 5: Mean shoot height (cm) of *Chrysophyllum albidum* seedlings from different fertilizer sources.

Treatments	Weeks							
	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH
T_1	9.10	10.12	31.30	31.30	31.40	32.70	32.70	33.20
T_2	9.50	10.40	31.20	31.20	32.60	33.30	33.70	34.80
T_3	10.3	10.73	33.60	33.70	34.40	34.73	35.10	35.80
T_4	9.20	9.93	30.7	30.80	31.00	31.10	31.70	32.40

T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control

Table 6 shows mean collar diameter growth of seedlings subjected to different fertilizer types. At the end of 8th week of growth study, T_1 had the highest collar diameter (0.87cm) followed by T_2 (0.70cm).This implies that organo mineral and NPK were effective in girth development of the plants. According to Adelani and Mohammed, (2019) organic minerals and NPK play important roles in the regulation of processes in the plant such as osmosis and enzyme activities all of which enhance sustainable growth development.

Table 6: Mean Collar diameter (cm) of *Chrysophyllum albidum* seedlings from different fertilizer sources.

Treatments	Weeks							
	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH
T_1	0.23	0.20	0.63	0.63	0.60	0.60	0.83	0.87
T_2	0.21	0.22	0.55	0.55	0.60	0.61	0.70	0.70
T_3	0.22	0.21	0.50	0.50	0.62	0.62	0.63	0.63
T_4	0.23	0.20	0.60	0.60	0.59	0.60	0.60	0.60

T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control

The mean leaf production of *C. albidum* to different fertilizer types is presented in Table 7. The T_2 and T_3 had highest mean leaf production of (15) while T_1 and T_4 had mean leaf production of (14) at the end of 8th week of study. The mean leaf production by all the treatments could be attributed to nutrients component of the three types of fertilizers. Most especially as N is responsible for vegetative growth. This agrees with the work of Okunomo (2010) who obtained higher number of leaves in soil amended with manure than other treatments (topsoil, sharp sand, sawdust, clay soil) with *Parkia bicolor*. Similar observation has been reported by Ugese, (2010) on the *Tamarindus indica* L seedlings.

Table 7: Leaf Production of *Chrysophyllum albidum* seedlings from different fertilizer sources.

Treatments	Weeks							
	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH
T_1	8.0	8.0	8.67	10.00	10.00	10.00	12.00	14.00
T_2	7.3	7.3	7.67	8.00	9.00	9.00	13.00	15.00
T_3	7.3	7.3	8.0	9.00	9.00	9.00	14.00	15.00
T_4	7.67	7.7	8.00	8.00	9.00	9.00	14.00	14.00

T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control

Table 8 shows effects of three types of fertilizers on mean leaf area (cm^2) of *C. albidum*. At the end of 8th week of study, T_1 had the highest mean leaf area (13.40cm^2) followed by T_2 (12.80cm^2). This is an indication of potential of mineral components in the fertilizers enhancing the growth and development of the seedlings of the species. Peter-Onoh *et al.*, (2014) on *Monodora myristica* seedlings planted in potting mixture amended with inorganic and organic fertilizers reported the efficacy of mineral nutrients in enhancing growth of the seedlings especially on area of leaves produced.

Table 8: Mean Leaf area (cm^2) of *Chrysophyllum albidum* seedlings from different fertilizer sources.

Treatments	Weeks							
	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH
T_1	5.01	4.98	5.03	5.04	6.04	7.50	7.50	13.40
T_2	4.99	4.99	4.95	4.95	5.20	5.80	6.40	12.80
T_3	5.20	5.20	5.13	5.13	5.14	5.16	5.20	12.40
T_4	4.04	4.04	3.90	3.90	4.10	4.31	4.36	12.40

T_1 = Organo-mineral fertilizer, T_2 = NPK 15:15:15, T_3 = Organic fertilizer and T_4 = Control

CONCLUSION

Mechanical scarification enhanced germination of the seeds of *C. albidum* when compared with control treatment. Similarly, the growth and sustainable development of the seedlings of *C. albidum* was improved by the fertilizers within the period of study. There were evidences of immediate release of nutrients for plant growth by organo-mineral and inorganic fertilizer sources which led to geometric progression. In case of organic fertilizer source, nutrients were gradually released in arithmetic order and at a point increased geometrically and still have residual effect thus long lasting for the plants uptake. Organic source also from records improve soil quality and so make such soil sustainable for planting.

It is evident from the findings that growth media amendment with the use of organic and inorganic fertilizers catalyzed the growth of species sustainably. Therefore, massive production of seedlings of Africa Star Apple for orchard establishment in view of its sustainable development and socio-economic significance can be achieved through subjecting seeds to mechanical scarification and growth enhancement at seedling stage in the nursery with organic manure.

REFERENCES

Adelani. D. O and Mohammed, R (2019): Effect of sowing and growth media on the seed germination and early seedling growth of african star apple (*chrysophyllum albidum* g. Don) *Journal of Sustainable Environmental Management.* Vol. 11, 127-143, 2019. ISSN: 2141-0267 www.awife.org.ng/publications/jsem.html

Adelani, D.O., Adedire, M.O., Aduradola, M. A., Anamayi, S.E and Ogunkalu, O. A. (2014a).

Storability of tropical forest seeds for sustainable development in the world. A review. *Biological and Environmental Sciences Journal for the Tropics* 11(1): 38-42.

Adelani, D.O., Suleiman, R. A., Akesode, H. A and Akande, M. T. (2014b). Effect of sources

and rates of organic fertilizer on the growth of *Chrysophyllum albidum* seedlings. *Organic Agriculture Research: A Catalyst for Sustainable National Agricultural Transformation Agenda. In:* Olabiyi, T.I and Bolarinwa, I.F *(Eds). Proceedings of the 10th National Conference on Organic Agriculture,* pp 65-73.

Aduradola, A.M., B.F. Adeola and M.O. Adedire. 2005. Enhancing germination in seeds of African Star Apple, *Chrysophyllum albidum* (G. Don). *Journal of Food, Agriculture and Environment* 3(2):292-294.

Agbo, C.U and Omaliko, C.M. (2006). Initiation and growth of shoots of *Gongronema latifolia* (Benth) stem cutting in different rooting media. *Africa Journal of Biotechnology* 5: 425-428.

Aina, A. B. J; Olubode, O.O and Joseph-Adekunle, T.T . (2012). Growth and yield responses of okra (*Abelmoschus esculentus* L) to different organic and inorganic manures in South Western Nigeria. *Organic Agriculture and National Development. In*: Solomon, M.G., Egrinya-Eneji; A., John, N.M; Ukeh, D.A and Okon, P.B. (Eds). *Proceedings of the 8th Annual Conference of Organic Agriculture Project in Tertiary Institutions in Nigeria*. (OAPTIN) Pp51-56.

Aruleba, J.O and Fasina, A.S. (2004). Soil degradation and vegetable production in South Western Nigeria. *Proceedings of the 22nd Annual Conference of Horticultural Society of Nigeria,* Kano. Pp134-137.

Awodola, A. M. (1991). *Soil moisture-nutrient relations of Parkia biglobosa* (Jacq) R.Br.Ex.G.Don. Ph.D Thesis. University of Ibadan, Nigeria. 319pp.

Belay, A., Classens, A. S., Wehner, F.C and Beer, J. D. (2001). Influence of residual manure on selected nutrient elements and microbial composition of soil under long-term crop rotation. *South African Journal of Plant and Soil* 18:1-6.

Fagbenro, J.A.A. and A.P. Aluko (1987): Fertilizer use in the production of Forest Trees, Proc. of the National Fertilizer seminar held at Port-Harcourt, October 28 -30.

FAO (1977): Analysis of an FAO Survey of Post-harvest Crop Losses in Developing Countries. FAO United Nations, Rome, Pp. 85, cited by Ladipo D.O. in proceedings of a National Workshop on the potentials of the Star Apple in Nigeria, Published by Daybis Limited, Ibadan.

FRIN, (2018): Forestry Research Institute of Nigeria, Annual Meteorological Report.

Gbile Z. O., (1997): Taxonomy of the African Star Apple (C. albidum) and related species.

Ikyaagba, E. T., Amonum, J. I., Usman, I. A., Asiegbu, E. A and Amagu, K. (2018). Effects of growth media on germination and early growth of *Afzelia africana sm ex pers. Annual Research and Review in Biology* 29 (2): 1-7.

Iren, O.B., .John; N. M., Imuk, E . A and .Ekpenyong, K. U. (2012). Influence of pig manure rates and NPK (15:15:15) fertilizer on soil chemical properties and dry matter yield of fluted pumpkin (*Telfairia occidentalis* Hook F.) *Organic Agriculture and National Development. In*: Solomon, M.G., Egrinya-Eneji, A., John, N.M; Ukeh, D. A and Okon, P.B. (Eds). *Proceedings of the 8th Annual Conference of Organic Agriculture Project in Tertiary Institutions in Nigeria*. (OAPTIN) Pp13-17.

Iren, O.B; Asawalam, D.O., Osodeke, V. E and .John, N.M. (2011). Comparative effects of animal manures and urea fertilizer on soil properties in a rainforest ultisol. *Journal of Agricultural Research and Policies 6* (2): 51-56.

Isah (2012) (*Parkia biglobosa*)., Olujobi *et al.* (2009) (*Afzelia africana*)., Morteza *et al*. (2011) (*Citrullus cococynthis*)., Aduradola *et al.* (2005) (*Chrysophyllum albidum*).

Isah, A.D. (2012). Effects of Pre-treatments on seed germination of *Parkia biglobosa* and *Tamarindus indica*. *In*: Onyekwelu, J.C., Agbeja, B.O., Adekunle, V.A.J., Lameed, G.A., Adesoye, P.O and Omole, A.O. (eds). De-reservation, Encroachment and DeforestationImplications for the Future of Nigerian Forest Estate and Carbon Emission Reduction.

Jimenez M., (1983). Factor affecting Market Quality of Horticultural produce. In proceedings of the ASEAN Workshop on Transportation and Handling Techniques of Horticultural

Kafaru E. (1994): Immense Help from Natures Workshop cited by Ladipo D.O. on pp.31-32 – in proceedings of National Workshop on the potentials of the Star Apple in Nigeria. Published by Daybis Limited, Ibadan.

Keay, R.W.J. (1989): Trees of Nigeria. A Revised Version of Nigerian Trees, Vol. I and II (1960 – 1964): 476pp.

Morteza, S., Farajollah, T. and Soheila, N. (2011). Comparison the effect of differenttreatments for breaking seed dormancy of *Citrullus colocynthis*. *Journal of Agricultural Sciences* 3(4):62 67.

Obiefuna, J.C., Ibeawuchi, I.I., Baiyeri, K. P and Obiefuna, C. A. (2012). Field Experimentation and Communication for Agricultural Development. DFC Publishers, Owerri. ISBN: 976-976-979-810-5, pp. 142.

Okafor, J. C., and Fernandex E.C. M. (1987): The Compound Farms of South Eastern Nigeria: A Predominant Agro-Forestry Garden System with Crops and small Livestock. Agro-forestry systems 5: 153 -168.

Okpara, I. M and Mbagwu, J.S.C (2003). Effectiveness of cattle dung and swine waste as biofertilizer on an ultisol at Nsukka. *Proceedings of the 28th Annual Conference of Soil Science Society of Nigeria* 260-263.

Okunomo K., Ladipo D. O., Adewusi H.G. and Adebisi A.A., (1997). Preliminary study on influence of Fruits Harvest methods on pest infestation and Loss in Fruit Quality in the African Star Apple in S.W. Nigeria.Pp.95 – 102.proceedings of the National Workshop on the Potentials of the Star Apple in Nigeria. Published by Daybis Limited, Ibadan.

Okunomo, K. (2010). Germination and Seedling growth of Parkia bicolor (A. Cheu) as influenced by nursery techniques. *Journal of Sustainable Development* 7(1):37-43.

Okunomo, K., Ureigho, U.N and Opute, H.O. (2006). The effect of soil amendment on the performance of *Gambeya albida* (Linn) seedling. *Agricultural Journal* 1(4): 262-265.

Olagunju, F.B. and S.A. Ekwebelam (1985): Forest Nursery practice in Nigeria. Forest Resource Institute Res. Monograph No. 13.

Olujobi, O.J., Olayode, O.O. and. Dahunsi, O.M. (2009). Breaking seed dormancy in *Afzelia africana (sm. Ex. Pers*) towards plantation establishment for sustainable production. *In*: Popoola, L; Idumah, F.O; Adekunle, V.A.J and Azeez, I.O. (eds). *The Global Economic Crisis and Sustainable Renewable Natural Resources Management*. *Proceedings of the 33rd Annual Conference of the Forestry Association of Nigeria*. Pp. 205 – 212.

Peter-Onoh, C. A., Obiefuna, J.C., Ngwuta, A. A., Onoh, P. A., Ibeawuchi, I. I., Ekwugha, E. U., Emma-Okafor, L. C., Nze, E. O., Orji, J. O. and Onyeji, E.C. (2014). Efficacy of five different growth media on seedling emergence and juvenile phenology of *Monodora myristica* (African nutmeg, *Ehuru*) in the Nursery. *Journal of Agriculture and Veterinary Science*, 7(5): 60-63.

Sakin, U.O., Ercisli, S., Anapali, O and Esitken, A. (2005). Effect of pumice amendment on physical soil properties and strawberry plant growth. *Journal of Central European Agriculture (JCEA),* 6 (3):361-266.

Salami, K. D. and Lawal, A. A. (2018). Description of Economical Trees and Shrubs species in Northern part of Nigeria and their potentials. A proceeding of the 6th Biennial National Conference of the Forests and Forest Products Society. April 23th-27th, 2016, Pp136-144.

Sarrantonio, M., (1991): Methodologies for Screening Soil Improvement Legumes. Rodale Institute Research Center, Kutztown, U.S.A.

Ugese, F. D. (2010). Effect of nursery media on emergence and growth of tamarind (*Tamarindus indica* L) seedlings. *Journal of Animal and Plant Science*, 8(2): 999-1005.

Wilson, S. B., Stoffella, P. J and Graetz, D.A. (2001). Use of compost as a media amendment for containerized production of two subtropical perennials. *Journal of Environmental Horticulture,* 19(1):37-42.

ABOUT THE AUTHOURS:

Adeboyin Funmi Aderounmu. Ph.D (Silviculture); Chief Lecturer; Provost, Federal College of Forestry, Jericho Hill Ibadan

Asinwa Israel Olatunji. Ph.D (Silviculture and Forest Biology); Principal Research Fellow. Forestry Research Institute of Nigeria, Jericho Hill Ibadan.

Abayomi Ayodeji. Higher Forest Technologist, Federal College of Forestry, Jericho Hill Ibadan