EFFECT OF SEED WEIGHTS ON THE GERMINATION AND EARLY SEEDLING GROWTH OF AFRICAN STAR APPLE (*Chrysophyllum albidum* G. DON)

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Abstract
There is paucity of information on the choice of quality planting stock right from appropriate selection of seed weight for indigenous priority species in the tropics. In this light, investigation was conducted on the effect of seed weights on the germination and early seedling growth of Chrysophyllum albidum in the nursery of Federal College of Forestry Mechanization, Afaka, Kaduna State, Nigeria. The experiment was laid out in a Completely Randomized Design with five replicates to assess the effect of seed weights (1.2, 1.5 and 1.8g) on the germination and early seedling growth of Chrysophyllum albidum. A significant germination (100%), mean germination time (39days), carbohydrate content(71.63%), height (13.67cm)., number of leaves (3.4)., leaf area (26.74cm^2)., fresh weight (1.35g), dry weight (0.45g) and biomass value (0.0095g/cm^2) were recorded in seeds and seedlings of heaviest seeds (1.8g). Investigation revealed that highest girth (1.00cm) and leaf area index (0.63) were recorded from seedlings of heaviest seeds as well. Seed weight influences seed germination and seedling growth of C. albidum. The study therefore recommends planting of 1.8g of C. albidum seeds for the mass production of its seedlings in agroforestry nurseries.

Keywords*:* Indigenous, Compound Farm, Agroforestry, Priority Species, *C. albidum.*

Introduction

The current trend in agroforestry is to propagate priority species of high potentials with challenges (Adelani et al., 2018a). The World Agroforestry Centre (ICRAF) has identified African star apple as one of the top five priority tree species for domestication in the African humid tropics (Tchounjeu et al., 2002). African star apple or White star apple, Chrysophyllum albidum is one of such priority tree species. Chrysophyllum albidum is a climax tree species of tropical rainforest that belongs to the family Sapotaceae (Olaoluwa et al., 2012; Wole, 2013) which has up to 800 species and make up almost half of the order (Ehiagbonare et al., 2008). The Yoruba name is "Osan Agbalumo" (Rahaman, 2012) while in Igbo and Hausa languages, it is called "Udara" or "Udala" (Wole, 2013) and Agwaluma or Agwaluba respectively.

C. albidum has been noted to be of great economical (Oboh et al., 2009, Onyekwelu et al., 2011 and Olaoluwa et al., 2012)., nutritional and medicinal (Adisa, 2000., Egunyomi et al., 2005 and Onyekwelu and Stimm, 2011) and industrial (Amusa et al., 2003, Olaoluwa et al., 2012, Rahaman, 2012) as well as ecological values (Aduradola et al., 2005). In spite of enormous benefits of C. albidum, it has been greatly neglected particularly with respect to its regeneration (Adelani et al., 2014, Adelani et al., 2016, Adelani et al., 2017). Seed is paramount in the establishment of any plant species; since both artificial and natural regeneration programmes start with availability of adequate supply of seeds (Amusa**,** 2011).

Over the past years, many investigators studied relationships between seed mass, germination rate and seedling vigour for different herb, shrub and tree species but it remained unexplored for C. albidum seeds. There is dearth of quantified information on the effect of seed weights on the germination and seedling growth of C. albidum for biodiversity conservation. Each species has particular requirements for seed germination and germination requirements for native species are often unknown (Navarro and Guition, 2003, Cerabolini et al., 2004). In view of this, study was conducted to assess the effect of seed weights on the germination and seedling growth of C. albidum for mass production of its seedlings for agroforestry systems.

Materials and Methods

The study was conducted in the screen house of the Federal College of Forestry Mechanization, Afaka, Kaduna. The college is located in the Northern Guinea Savannah ecological zones of Nigeria. It is situated in Igabi Local Government Area of Kaduna State, Nigeria. It is located between latitude 10° 34′ and 10° 35′ and longitude 7° 20′ and 7° 21′ (Adelani, 2015). The mean annual rainfall is approximately 1000 mm. The vegetation is open wood land with tall broad leaved trees (Otegbeye et al., 2001). The fruits of C. albidum were collected from mother trees in Osiele village, Ogun State, Nigeria. C. albidum seeds extracted freshly were used for the experiment. The viability of the randomly selected seed samples was assessed with the cutting method (Schmidt, 2000). The river sand used for

the experiment was collected from the floor of the college dam, sieved through 2mm sieve and then sterilized in the laboratory oven at 160 °C for 24 hours. The polythene pots used were 20x10x10cm^3 dimensions and filled with the sterilized river sand and saw dust and arranged in the screen house.

To assess the effect of seed weights on the germination and seedling growth variables of C. albidum, a Completely Randomized Design with five replications was involved. The total number of three hundred (300) seeds extracted from the fruits was used for the experiment. The seeds were washed and air dried for 30 minutes. The three seed weights of the samples of the seeds sorted out by sizes were determined by weighing the seeds on Mettler Top loading Weighing Balance (Model Mettler PM 11-K). Based on the categorization of Adelani et al.(2018b), the seed weights of C. *albidum* were classified into 1.2, 1.5 and 1.8g respectively. The seed weights (1.2, 1.5 and 1.8g) were soaked in 50 °C water for 10 seconds. Twenty seeds represented a replicate. Five replicates were planted in 4cm depth of equal mixture sterilized river sand and saw dust (50:50). Nothing of successful germinated seeds was as described by Hossain et al. (2005). Germination count was taken by recording the number of seeds germinated every three days as suggested by Schmidt (2000). Final germination count was taken when no further germination took place for several days. Germination count was converted to germination percentage. Germination percentage and mean germination time were estimated using the following formula (equations 1 and 2) as suggested by Schelin et al. (2003).

Germination percentage was computed using the formula:

$$Germination\ Percentage = \frac{Totalseedgerminated}{Totalseedsown} x\ 100 \quad (1)$$

Mean germination time was computed using the formula:

$$MGT = \frac{\sum(f_x)}{\sum X} \quad \text{Schelin } et\ al. \text{ (2003)} \quad (2)$$

Where: x is the number of newly germinated seeds on each day; f is the numbers of days after seeds were set to germinate; X is the Total number of seeds that germinated at the end of the experiment. The carbohydrate content was analyzed in laboratory.

The successful germinated seeds were thinned to one per pot. Seedling growth variables were taken every two weeks for two months. Variables assessed include: seedling height (using meter rule) and collar girth (using venier calliper). The leaves were counted manually for number of leaves. Leaf area was obtained by linear measurement of leaf length and leaf width as described by Ugese *et al.* (2008).
LA=4.41+1.14LW

Where: LA= leaf area; LW= Production of linear dimension of the length and width at the broadest part of the leaf; Leaf Area Index =leaf area/ land area; % Moisture Content= Weight of fresh seeds- Weight of dry seeds/ weight of fresh seeds x100; Biomass = Dry Weight (of above ground tissues)/ Plot Area (g/m^2) (g/cm^2) or (kg/m^2) (SOP, 1994)

The data for the study were subjected to one-way analysis of variance (ANOVA). Comparisons of significant means were accomplished using Fischer's Least Significant Difference (LSD) at 5% level of significance.

Results and Discussion

Effect of Seed Weights on Germination Profile and Carbohydrate Content

The result of effect of different seed weights on the germination and carbohydrate content of *C. albidum* is represented in Table 1. A significant germination percentage value of 100% was recorded from the heaviest seeds with greatest carbohydrate content (71.63%). This is an indication that germination percentage increase with the increasing carbohydrate of the seeds, owing to the ability of carbohydrate content to enhance the energy for germination of seeds. This is also in line with reports of Khan and Shankar (2001), Ajiboye *et al.* (2009), Sangare (2012).

The result of the effect of seed weights on mean germination time of *C. albidum* showed that heaviest seeds germinated within shortest periods of time of 39 days compared to heavy seeds that germinated on 79 days. This result is in consonance with the reports of Khan, (2004), Kaydan and Yagmur (2008) and Norden *et al.* (2008). A significant germination percentage (100%) and least mean germination time (39 days) were recorded for heaviest seeds (Table 1). It can be deduced from the result that heaviest seeds germinate higher and earlier. This result is in the same consonance with the reports of Khan and Shankar (2001), Khan *et al.* (2002), Gholami *et al.* (2009) Hojjat (2011) and Omokhua *et al.* (2015). Contrary to the findings of this study, the investigators as Upadhaya *et al.* (2007); Santos *et al.* (2009); Roshanak *et al*. (2013); Souza and Fagundes (2014) concluded that small seeds germinate higher and earlier. Higher and earlier germination percentage recorded in small seeds was adduced to its ability to get food reserves (Rastegar and Kandi 2011) and water (Indira *et al*., 2000; Tilki and Alptekin, 2005; Sadeghi *et al.,* 2011) faster than large seeds**.**

Effect of Quality of Seedlings on Selected Growth Variables

Heaviest seeds had highest germination percentage, speed of germination, carbohydrate and seedling growth (Table 1). Cicek and Tilki (2007) concluded that large seeds in *Castanea sativa* have better germination and survival and seedling growth. Ahmeda *et al.* (2019) concluded that seed germination, plant height, number of leaves, leaf area, stem diameter and number of seeds, increased as seeds size of *Helianthus annus* increased. Growth characteristics of peanut plants, such as crop

emergence, plant height and number of leaves were higher in plots where large seeds were sown in comparison to plots with other seed sizes (Olayinka *et al.,* 2016).

Higher and earlier germination in heaviest seeds influenced the seedlings growth. Various investigators such as Cookson *et al.* (2001) (*Lolium perenne*)., Nagaraju (2001) (*Helianthus annus*), Nerson (2002) (*Cucumis melo*)., Balamurugan *et al.* (2004) (*Carthamus tinctorius*)., Willenborg *et al.* (2005) (*Avena sativa*)., Menaka and Balamurugan (2008) (*Amaranthus Cv.CO$_5$*) and Mandal *et al.* (2008) (*Hyptis suaveolens*) have concluded that large seed sizes enhanced increased germination percentage, speed of germination, seedling vigour (Yanlong *et al.,*2007) and other seed quality parameters as well as related agronomic traits.

A significant height (13.67cm), fresh weight (1.35g), dry weight (0.45g) and biomass value (0.0095g/cm^2) were recorded in seedlings from heaviest seeds (1.8g) (Table 1). This result is in consonance with the reports of Owoh *et al.* (2011) who stated that large seed size of *Gmelina arborea* had the best performance in terms of shoot and root dry weight which was significantly different from other seed sizes. Similar result was obtained by Taleghani *et al* (2002) on sugar beet.

Table 1: Effect of Seed Weights on Germination and Seedling Growth Parameters of *C. albidum*

Seed Size	S.W (g)	M.C (%)	C.C (%)	MGT (Days)	G (%)	H (cm)	Gt (*cm*)	NL	LA (cm^2)	LAI	FW (g)	DW (g)	BV(g/cm^2
S	1.2	4.05	69.12	79	18^{bc}	9.07^{b}	0.85^{a}	2.17^{b}	16.51^{b}	0.39^{a}	0.60^{b}	0.15^{b}	0.003^{b}
M	1.5	4.18	69.33	60	45^{b}	9.83^{b}	0.97^{a}	2.50^{b}	25.07^{a}	0.59^{a}	1.15^{a}	0.35^{a}	0.008^{a}
L	1.8	4.27	71.63	39	100^{a}	13.67^{a}	1.00^{a}	3.37^{a}	26.74^{a}	0.63^{a}	1.35^{a}	0.45^{a}	0.0095^{a}
SE±	-	-	-	6.1	7.77	0.83	0.75	0.22	1.47	1.05	0.07	0.04	0.0009

*Means on the same column having different superscripts are significantly different (P<0.05).S-Small (2.0-2.2cm length), M-Medium(2.4.0-2.6cm length), L- Large (2.8-3.0cm length), S.W- Seed weight C.C – Carbohydrate Content, MGT- Mean germination time, G- Germination percentage, H-Height, Gt- Girth, NL-Number of leaves, LA-Leaf Area, LAI-Leaf area index, FW-Fresh Weight, DW-Dry weight, BV-Biomass value

Conclusion

Out of all the challenges that are confronting the choice of quality planting stock, the poor selection of the seed weight in seed lot appears to be critical. The problem of poor selection of seed weight from seed lot takes time to discover let alone corrected. It is therefore paramount to be careful in selection of appropriate seed weight from seed lot of high physiological quality to guarantee future planting stock as well as growth, development and high productivity. In an attempt to prevent extinction of our indigenous priority tree species, conservation efforts should be geared towards propagation of them. Appropriate selection of quality plant stock of priority species which start right from choosing appropriate seed weight needs to be embraced. *Investigation conducted into selection of appropriate seed weight of C. albidum revealed that* for maximum germination percentage and seedling growth, 1.8g seeds need to be planted.

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