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EFFECT OF THE BOTANICAL PELLETINGS AND STORAGE PERIODS ON THE GERMINATION OF AFRICAN STAR APPLE (*CHRYSOPHYLLUM ALBIDUM* G. DON) SEEDS

D. O. ADELANI, O.S. AMOS AND S. MAIKANO

Federal College of Forestry Mechanization, P.M.B 2273, Afaka, Kaduna, Nigeria
***Corresponding Author**: adelani.olusegun@yahoo.com **Tel**: 2347038953146

ABSTRACT

There is paucity of quantified information on the simple, safe and affordable methods of invigorating seeds and storage of recalcitrant seeds. In this light, investigation was conducted in the screen house of the Federal College of Forestry Mechanization, Afaka, Kaduna on the effect of the botanical pelletings and storage periods of *C. albidum* seeds. A seed pellet is a coating, usually of clay mixed with other inerts, which streamlines the size, shape, and uniformity of a small, non-round seed. A split-plot experimental design with four (4) replications was laid down to assess the effect of botanical pelletings with the leaves of six agro-forestry tree species (*Gliricidia sepium*, *Leucaena leucocephala*, *Albizia lebbeck*, *Acacia auriculiformis*, *Parkia biglobosa* and *Dacryodus edulis*) and storage periods (0, 1, 2, 3 and 4 weeks) on the germination of *C. albidum* seeds stored in the refrigerator. The data were subjected to analysis of variance (ANOVA)using SAS (2003)software. The percentage germination of seeds pelletized with *G. sepium*, *L leucocephala*, *A. lebbeck*, *A. auriculiformis*, *P. biglobosa and D. edulis* ranged between 18.50%-42.00%, 8.3%-13.60%, 5.2%-18.80%, 3.6% -16.30%, 5.0%-14.30%, and 2.5%-11.10%, for 2-8 weeks respectively. The percentage germination of seeds stored for 0, 1, 2, 3 and 4 weeks ranged between 8.50%-21%, 4.70%-24.58%, 9.42%-22.75%, 8.67%-19.58% and 3.33%-8.83% respectively. The percentage germination of seeds pelletized with the leaves of *G. sepium*, *L. leucocephala*, *A. lebbeck*, *A. auriculiformis*, *P. biglobosa* and *D. edulis* and stored for storage periods ranged between 1-65%, 0-30%, 0-30.5%, 1-25%, 0-20% and 0-30%. Botanical pelletings and storage periods significantly ($P<0.05$) enhanced the germination of *C. albidum* seeds. Highest germination percentage of 65% was recorded for seeds pelletized with *G. sepium* leaves and stored for 3 weeks. The research therefore recommends seed pelleting with *G. sepium* leaves and storage for 3 weeks for mass production of *C. albidum* seedlings for agro-forestry systems.

Keywords: *Chrysophyllum albidum,* Agro-forestry, Seed storage periods, seed germination,

INTRODUCTION

Chrysophyllum albidum known as African star apple, belongs to the family Sapotaceae which has up to 800 species (Ehiagbonare *et al.,* 2008). It is a tropical forest tree species that has been incorporated into traditional agro-forestry systems. It is indigenous multipurpose tree species with enormous potentials for agro-forestry (Ureigho and Ekeke, 2010). The species is called "Udala", Agbalumo and Agbaluma in Igbo, Yoruba, and Hausa languages, respectively. Its natural occurrences have been reported in diverse ecozones in Nigeria, Uganda, Niger Republic, Cameroon and Coted'Ivoire (Bada, 1997).

In recent times, *C. albidum* has become a crop with commercial value in Nigeria (Oboh *et al.,* 2009) due to awareness of its nutritional and medicinal value (Onyekwelu and Stimm, 2011). ICRAF (2007) noted that the fleshy and juicy fruits of the species, which are popularly eaten, are potential source of soft drink. The fleshy pulp of the fruits has been found to have higher contents of ascorbic acid than oranges and guava (Amusa *et al.,* 2003). The fruits are also suitable for the production of fruit jams and jellies (Ureigho and Ekeke, 2010). Also, *C. albidum* fruit has been also reported to be an excellent source of vitamins, irons, and flavours to diets (Adisa, 2000). The seeds are used for local games or discarded (Bada, 1997). The seeds of the species are sources of oil, which are used for diverse purposes (Ugbogu and Akukwe, 2009). The fruits contain 90% anacardic acid which is used industrially in protecting wood and as source of resin. *Chrysophyllum albidum* leaves are used as emollients and for the treatment of skin eruptions, diarrhoea and stomach ache, etc (Adisa, 2000).

In spite of the enormous benefits of *C. albidum*, it has been neglected with the respect to its domestication. To avert total extinction of some of the important forest fruit species, they must be cultivated more intensely through improved propagation either by seed or stem cuttings(Dolor, 2013). Domestication through propagation serves as ex-situ conservation.*Ex-situ* conservation efforts are necessary to minimize the loss of genetic diversity, reduce the risk of extinction (Godefroid *et al.,* 2010), and produce propagation material for the expansion or re-introduction of populations (Godefroid *et al.,* 2010). This approach is preferred in situations where the populations are in real danger of physical destruction or genetic deterioration due to excessive pressures in their natural habitat (Nguyen *et al.,* 2014). Seeds are still important starting materials for propagation of many vital tree species (Mng'omba*et al.,*2007)**.** Furthermore, the use of seeds as propagules has been considered the easiest and cheapest, and the most common means for many agro-forestry and timber tree species (Akinnifesi *et al*. 2007). Generally, this has been attributed to the fact that seeds are often easy to produce and handle (Black, 1989). Comparatively, vegetative propagation methods such as grafting, budding and air layering require some skills and knowledge. Seeds are important in mass multiplication of tree planting materials as well as tree improvement through selection (Mng'omba *et al.,* 2007)**.** According to Bewley and Black (1983), seed conservation has been the most reliable and widely used method for *ex situ* storage. Propagation from seed is inexpensive and usually effective and is therefore a variable method for their ex-situ conservation (Abirami *et al.,* 2010).

Often, seed ripening and collection do not correspond with the time of seedling production, while some species do not produce seeds all year round (Dolor, 2013). Even if fruiting is regular and abundant every year, it may be more cost-efficient to collect surplus seeds to cover the needs of few consecutive years (Schmidt, 1988). Hence, efficient storage of seeds is indispensable to ensure continuous and cost-effective supply of tree seedlings, which is a prerequisite for the success of any mass afforestation programme **(**Umarani *et al.,* 2015).

Moreover, the intelligent manipulation and appropriation of storage life of seeds gives 95% germinability and enhances seedling vigour in the nursery (Adelani *et al.,* 2014a). Normally, *C. albidum* seeds should not be

kept longer than 5th day of extraction before sowing or else it will lose viability (Adelani *et al.,* 2016). Denton (1997) reported that *C. albidum* seeds are recalcitrant and should therefore be sown almost immediately after maturing to ensure adequate germination. Recalcitrant seeds, maintain relatively high moisture content (typically 40-50%), are damaged by desiccation and are sensitive to chilling. *Chrysophyllum albidum* seeds have very high viability (> 80% at maturity), which may decline rapidly with storage, because it is recalcitrant (Aduradola *et al.,* 2005; Adegoke *et al.,* 2014; Adelani *et al.,* 2016).

Seed management techniques are employed to invigorate the seed by modifying the physiological stamina of the seed (Srimathi *et al.,* 2013). Pelleting is one such physical treatment given to seeds to invigorate its vigour. A seed pellet is a coating, usually of clay mixed with other inerts, which streamlines the size, shape, and uniformity of a small, non-round seed such as those of lettuce, carrots, onions, and many herbs and flowers. Pelleting results in easier, safer, and more accurate mechanical seeding, thus reducing gaps in the field and the need for labour-intensive thinning (Gatch, 2016).

Some of the common benefits of pelleting are uniformity in seed size, precision planting; uniform stands with reduced seed rate, more insect and disease resistance, better performance under stress conditions and additional nourishment to the seedlings (Halmer, 2003). Pelleting was employed to overcome the problem of poor germination and seedling growth as well as survival of finger and brown top millets and vegetables (jute, amaranth, cat's whiskers) (Patrick *et al.,* 2016). Pelleting increased seed size by about 33-150% and a significant improvement in germination was observed for pelleted seed (Patrick *et al.,* 2016).

The studies on pelleting in agriculture especially in field crops are well exploited but in case of tree species it is very scanty **(**Srimathi *et al.,* 2013). There is dearth of information on the pelleting and storage of *C. albidum* seeds. Inadequate germinability and storability lead to paucity of seedlings for afforestation programme in agro-forestry systems. In an attempt to increase the germinability and storability of *C. albidum* seeds, the study investigates its pelleting and storage periods.

MATERIALS AND METHOD

Experimental Site

The pot experiment was conducted during the dry season (that is December) of 2015 at the screen house of Federal College of Forestry Mechanization, Afaka, Kaduna state, Nigeria. The college is located within the Northern Guinea Savanna ecological zone and situated in Igabi Local Government Area of Kaduna State, Nigeria. The college lies between latitude 10° 35' and 10° 34'N and longitude 7° 21' and 7° 20'E (Adelani, 2015). The mean annual rainfall is approximately 1000 mm, with the lowest mean monthly relative humidity of about 29%. The soil is classified as sandy loam. The vegetation is open woodland with tall broad leave trees (Otegbeye *et al.,*2001).

Fruit Collection and Preparation

The fruits were collected from the mother tree at village near Federal University of Agriculture, Abeokuta, Ogun State. The seeds were extracted from the fruits, washed and air dried for thirty minutes. The river sand was collected from the floor of the College dam, passed through (2mm) sieve and sterilized at 160°C for 24 hours (Adelani and Joseph, 2014). The polypots of 20 x 25 x 25

cm^3 capacity filled with sterilized river sand in the nursery was used.

Experiment

The effect of the botanical pelletings and storage periods on the germination of *C. albidum* seeds was laid down using a split plot experimental design. Pelletings with leaves of six agro-forestry tree species (*Gliricidia sepium*, *Leucaena leucocephala*, *Albizia lebbeck*, *Acacia auriculiformis*, *Parkia biglobosa and Dacryodus edulis*)and storage periods (0, 1, 2, 3, and 4 weeks) constituted the main and subplot treatments, respectively. The effects of pelletings with leaves of each of the agro-forestry tree species and the period of storage on the germination of *C. albidum* seeds were assessed for 8 weeks beginning from the first day of germination. Ten (10) *C. albidum* seeds represented a replicate. Forty (40) seeds were coated with the mixture of clay (1.5g/seed), fungicides (0.5ml/seed), and leaves of agro forestry trees species (2.4g /seed) and 1ml of water. Pelleted seeds were stored on 0, 1, 2, 3, and 4weeks. Forty (40) seeds per week of storage in refrigerator were sown in the acid washed river sand at 4cm depth and watered twice daily at 200ml/seed. Seeds that were not coated and not stored served as control. Seeds were considered to have germinated after the emergence of plumule above the ground. Germination percentages were calculated as total number of seed germinated per total number of seed planted multiplied by 100.

$$\text{Germination Percentage} = \frac{Totalseedgerminated}{Totalseedsown} \times 100$$

Each sample of pulverized leaves of agro-forestry tree species was analysed chemically for nitrogen, phosphorus and potassium (NPK) content at the Ahmadu Bello University laboratory. Determination of total nitrogen and available phosphorus were done by MacroKjeldahi method. Extracts from the digestion of the leaves of the agro-forestry species were used to determine potassium by flame photometry. The dry weights of the leaves of agro-forestry tree species were determined, by the use of Mettle Top Loading Weighing Balance (Model-Mettler PM 11-K), after oven dried at 70°C for 72hours (Umar and Gwaram, 2006).

Data analysis

The data were collected on the potentials of botanical pelletings and storage periods on the germination of *C. albidum* seeds. The data were subjected to analysis of variance (ANOVA)using SAS (2003)software. Separation of significant means was accomplished using Fisher's Least Significant Difference (LSD) at 5% level of significance.

RESULTS AND DISCUSSION

Percentage NPK composition of the leaves of Agro-forestry tree species

The result of the analysis of NPK composition of the leaves of agro-forestry tree species is presented in Table 1. *G. sepium* leaves had highest percentage composition of 30.89% and 19.6% for nitrogen and phosphorus respectively. *D. edulis* leaves had the highest percentage composition value of 2.71% for potassium. The significant performance of *G. sepium* leaves is traceable to its highest composition of nitrogen and phosphorus. Similar observation was reported by Adelani *et al.* (2014b) who stated that the highest growth parameters recorded for maize planted in acid washed sand amended

with the leaves of *Gliricidia sepium* was adduced to its ability to release its highest nitrogen composition among other agroforestry trees species investigated.

Nitrogen which is component of *G. sepium* has ability to improve water absorption and protein synthesis and equally promote cell division and elongation of seeds (Crawford *et al.,* 2000). Nitrogen in *G. sepium* regulated developmental process as germination (Alboresi *et al.,* 2005). Phosphorus is an important component of *G. sepium* (Adelani *et al.*, 2014b) which help in the germination of seeds (Mengel and Kirkby 2001; Smith, 2014).

Table 1: Percentage NPK composition of the leaves of Agroforestry tree species

Agro-forestry tree spp	N%	P%	K%
Gliricidia sepium	30.89	19.6	2.07
Leucaena leucocephala	27.68	3.1	2.05
Albizia lebbeck	21.05	3.4	1.91
Acacia auriculiformis	26.96	0.1	2.17
Parkia biglobosa	27.44	10.6	0.84
Dacryodus edulis	27.64	1.1	2.71

Effect of the botanical pelletings and storage periods on the germination of *C. albidum* seeds

The result of the effect of the botanical pelletings and storage periods on the germination of *C. albidum* seeds is represented in Table 2. The percentage germination of seed pelletized with the leaves of *G. sepium, L. leucocephala*, *A. lebbeck*, *A. auriculiformis*, *P. biglobosa and D. edulis* ranged between 18.50%-42.00%, 8.3%-13.60%, 5.2%-18.80%, 3.6%-16.30%, 5.0%-14.30%, and 2.5%-11.10%, for 2-8 weeks respectively. Highest germination of 42% was recorded in seed pelletized with *G. sepium* leaves. The excellent performance of *G. sepium* leaves could be adduced to the fact that it enhanced the fertilization of *C. albidum* seeds. This is in consonance with the reports of Vijaya and Balamurugan (2011) who stated that seed pelleting added needy substance to the individual seed so that the seeds get invigorative effect on absorption of such materials, at initial watering by enriching the rhizosphere region of each and every seed as nutritive without physiological modification of seed but by simple physical alterations of the seed.

Similar reports have been made by Scott, 1989; Mani *et al.,* 1999; Gurunathan *et al.,* 2006; Govinden and Levantard (2008) and Srimathi *et al.,* (2013). This is also corroborated by the reports of Srimathi *et al.* (2013) on pelleting of *Jatropha curcasand Pongamia pinnata*with the leaf powder of *Azadirachta indica, Pongamia pinnata*and *Adhatoda vasica*. Srimathi *et al.* (2013) attributed the excellent

performance of *Pongamia pinnata* to its ability to correct soil moisture, contains gibberellins like substance which was synergistically activated to form indole acetic acid (IAA) and ability of its leaf component to act as chelating agent and activated the growth and development.

All pelletized *C. albidum* seeds performed better than that of the unpelletized seeds. This in consonance with the report of Woods (2014) who stated that pelleted seeds registered significantly higher germination and seedling vigour in red cedar and red paper compared to non-pelleted (control) under all soil types. Similar observation has been made on pelletings of *Jatropha curcas* and *Pongamia pinnata* **(**Srimathi *et al.,* 2013). This is also corroborated by Patrick *et al.* (2016) on dicotyledon and grass seeds. Contrary to earlier reporters, Arshadi and Asgharipour (2011) stated that pelleting with usage of extra covering material for sugar beet seed pelleting decreased viability and uniformity of seed germination.

Effect of storage periods on the germination of C. albidum seeds

The result of the effect of storage periods on the germination of *C.albidum* seeds is presented Table 2. The germination percentage values of seeds stored for 0, 1, 2, 3 and 4 ranged between 8.50%-21%, 4.70%-24.58%, 9.42%-22.75%, 8.67%-19.58% and 3.33%-8.83%, respectively. Highest germination percentage of 24.58% was recorded in seeds stored for 1 week. Based on this result, it can be inferred that C*. albidum* seeds can be stored for one week, for viability not to fall because it is recalcitrant. This is corroborated by the reports of Aduradola *et al.* (2005) and Adelani *et al.* (2014a).

The increasing periods of storage decrease the germination percentage of *C. albidum* seeds. Similar observation has made by Temel *et al.* (2011) who reported significant reductions in germination rate (from 79.93% to 30.68%) and germination percentage (from 95.99% to 58.41%) of *Pinus nigra* after 10-year storage. Also, Missanjo and Kapira (2015) reported that germination percentage and germination energy of *Pinus kesiya* seeds decreased with an increase of storage period. This is in consonance with the reports of Hilli *et al*. (2003) who stated that the germination of 10-year stored *Pinus sylvestris* seeds reduced significantly for both cold and frozen storage conditions. Contrary to earlier reporters, Kamotho *et al.* (2013) reported a significant increase in germination percentage of *Cleome gynandra* after 6 months of storage.

The ability of the *C.albidum* seeds to have decrease germination percentage with the increasing period of storage shows it is recalcitrant. Recalcitrant seeds are shed at relatively high moisture contents and are sensitive to desiccation (Anandalakshmi *et al.,* 2005). Similar observation has been made by Iakovoglou (2005) on recalcitrant seeds of the *Leucobalanus* subgenus of *Quercus* poses. Recalcitrant seeds germinate rapidly when sown fresh, but are sensitive to desiccation and freezing (Berjak and Pammenter, 2004; McDonald, 2004). This is in line with the reports of Liang and Sun (2000). Some recalcitrant seeds are shed when seed moisture is high and usually start germinating before and after shedding (Rajeeswari and Kaveriappa, 2000).

Table 2: Effect of the botanical pelletings and storage periods on the germination *C. albidum* seeds

Agoforestry tree species	Weeks	of	Germination		Period of Storage	Weeks	of	Germination	
	2	4	6	8		2	4	6	8
Gliricidia. sepium	18.50cd	21.5c	31.0b	42.0a	-	-	-	-	-
Leucaena leucocephala	8.3b	9.5b	13.6ab	18.30a	0	8.50c	13.42b	17.67ab	21.0a
Albizia lebbeck	5.20b	7.3b	14.40ab	18.8a	1	9.0d	17.75c	24.5b	47.0a
Acacia auriculiformis	3.6c	8.40b	15.10a	16.30a	2	9.42b	14.42ab	17.08ab	22.75a
Parkia biglobosa	8.67ab	10.92ab	15.80a	19.5a	3	8.67ab	10.92ab	15.80a	19.5a
Dacryodus edulis	7.60a	8.00b	11.1a	11.1a	4	3.33ab	5.83a	7.92a	8.83a
SE ±	3.15	3.15	3.15	3.15	SE ±	2.88	2.88	2.88	2.88

* Means on the same rows with the same alphabet are not significantly difference at ($P<0.05$)

Interactive effect of the botanical pelletings and storage periods on the germination of C. albidum seeds

The result of interactive effect of the botanical pelletings and storage periods on the germination of *C. albidum* seeds is presented in Table 3. The percentage germination of seeds pelletized with the leaves of *G. sepium*, *L.leucocephala*, *A. lebbeck*, *A. auriculiformis*, *P. biglobosa and D. edulis* and stored for 0, 1, 2, 3 and 4weeks ranged between 1-65%, 0-30%, 0-30.50%, 1-25%, 0-20% and 0-30% respectively. Highest germination percentage of 65% was recorded in seeds pelletized with *G. sepium* leaves and stored for 3 weeks. This is traceable to the fact that *G. sepium* leaves enhanced the storability of *C. albidum* seeds. Similar observation was recorded by Srimathi *et al.* (2013) who stated that seed pelleted with *Pongamia pinnata* leaf powder could be stored for up to six months with 48% germination.

Table 3: Interactive effect of pelleting and storage on the germination of *C. albidum* seeds

		Weeks of Germination			
Agro-forestry tree Species	**Period of storage**	**2**	**4**	**6**	**8**
Gliricidia sepium	0	1.00^{c}	5.00^{c}	10.5^{b}	20.0^{a}
Gliricidia sepium	1	1.50^{d}	10.50^{c}	25.00^{b}	35.0^{a}
Gliricidia sepium	2	15.50^{d}	21.00^{c}	45.0^{b}	50.0^{a}
Gliricidia sepium	3	25.00^{c}	40.00^{c}	60.00^{b}	65.00^{a}
Gliricidia sepium	4	20.00^{c}	35.00^{b}	40.00^{a}	40.00^{a}
Leucaena leucocephala	0	15.50^{bc}	20.00^{b}	25.00^{b}	25.00^{a}
Leucaena leucocephala	1	15.50^{bc}	15.50^{bc}	20.00^{b}	25.00^{a}
Leucaena leucocephala	2	6.00^{c}	15.00^{b}	15.50^{b}	30.0
Leucaena leucocephala	3	0.00^{b}	1.50^{b}	1.50^{b}	30.00^{a}
Leucaena leucocephala	4	0.00^{b}	0.00^{b}	0.50^{b}	11.00^{a}
Albizia lebbeck	0	10.50^{b}	11.00^{b}	15.00^{b}	25.50^{a}
Albizia lebbeck	1	5.50^{c}	15.50^{c}	25.50^{ab}	30.00^{a}
Albizia lebbeck	2	0.00^{c}	5.00^{c}	15.50^{b}	30.50^{a}
Albizia lebbeck	3	0.00^{c}	5.00^{c}	10.50^{b}	20.50^{a}
Albizia lebbeck	4	0.00^{c}	0.0^{c}	1.50^{ab}	2.00^{a}
Acacia auriculiformis	0	6.50^{c}	20.00^{b}	25.00^{a}	25.00^{a}
Acacia auriculiformis	1	1.00^{c}	10.50^{b}	20.50^{ab}	25.00^{a}
Acacia auriculiformis	2	5.00^{b}	6.00^{b}	15.50^{a}	15.50^{a}
Acacia auriculiformis	3	5.50^{b}	5.50^{b}	15.50^{ab}	20.00^{a}
Acacia auriculiformis	4	0.00^{b}	0.00^{b}	0.00^{b}	5.00^{a}
Parkia biglobosa	0	11.00^{ab}	15.00^{a}	15.50^{a}	15.50^{a}
Parkia biglobosa	1	10.00^{b}	15.00^{a}	15.50^{a}	16.00^{a}
Parkia biglobosa	2	0.00^{b}	0.50^{b}	20.00^{a}	20.00^{a}
Parkia biglobosa	3	0.00^{c}	0.00^{c}	15.00^{b}	20.00^{a}
Parkia biglobosa	4	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
Dacryodus edulis	0	6.00^{ab}	10.00^{b}	15.00^{a}	15.00^{a}
Dacryodus edulis	1	6.50^{c}	20.00^{b}	25.50^{ab}	30.00^{a}
Dacryodus edulis	2	0.00^{b}	0.00^{b}	0.50^{b}	5.00^{a}
Dacryodus edulis	3	0.00^{b}	0.00^{b}	2.00^{b}	10.00^{a}
Dacryodus edulis	4	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}
SE $\pm$		7.04	7.04	7.04	7.04

* Means on the same row on each treatment with the same alphabet are not significantly difference at ($P<0.05$)

CONCLUSION

Botanical pelleting was employed to overcome the problem of poor germination and storage of *C. albidum* seeds. The result revealed that pelleting and storage of *C. albidum* seeds enhanced germination. Seeds pelletized with *G. sepium* leaves gave highest percentage germination. Seeds of *C. albidum* need to be stored for 1 week to have highest germination percentage. *C. albidum* seeds pelletized with leaves of *G. sepium* and stored for 3 weeks had highest germination percentage. Botanical pelletings is used to invigorate the seeds by modifying its physiological stamina.

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