Original Research Article

Seed and Seedling Response of *Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. to Lengths of Storage at Room Temperature and Pretreatments

ABSTRACT

Aims: This study was carried out to evaluate the response of seeds and seedlings of *Irvingia gabonensis* to different lengths of storage at room temperature and pretreatments.
Study design: Randomized Complete Block Design was used.
Place and Duration of Study: The experiment was carried out at the nursery of the Department of Forest Resources and Wildlife Management, Ekiti State University, Ado-Ekiti, Nigeria.
Methods: Mature fruits of *I. gabonensis* were obtained from its area of natural range in Ekiti State, Nigeria. Depulped seeds were subjected to different lengths of storage and pretreatments. The different lengths of storage were Fresh, 7days, 14days, 21days and 28days represented as LS1, LS2, LS3, LS4 and LS5 respectively. Pretreatments were control, steeping in water at room temperature, soaking in hot water and scarification represented as PT1, PT2, PT3 and PT4 respectively.
Results: In LS1, germination began under PT1, PT2 and PT4 at 20, 19 and 21 Days after Sowing (DAS) respectively producing 90%, 100% and 100% germination respectively. Under LS2, seeds subjected to PT1, PT2 and PT4 germinated at 23, 24 and 23 DAS giving 90%, 90% and 80% germination respectively. At LS3, germination began in PT1, PT2 and PT4 at 26, 27 and 26 DAS producing 60%, 90% and 60% germination. However, seeds subjected to PT3 did not germinate throughout duration of experiment. Although, Analysis of Variance revealed significant difference at certain assessment period for seedling growth variables, there were no marked differences.
Conclusion: Seeds of *Irvingia gabonensis* can be successfully stored for up to four weeks at room temperature without a significant loss in viability although germination percentage would reduce with increasing length of storage. Soaking *I. gabonensis* seeds in water at room temperature can be adopted for pretreating its seeds prior to sowing although untreated seeds still produced good germination.

Keywords: Viability, Germination, Room temperature storage, Growth variables

1. INTRODUCTION

Tropical forest is replete with variety of indigenous fruit trees many of which are neglected and underutilized. As a matter of fact, most of these fruits are not known to the younger generation. One of these fruit trees is *Irvingia gabonensis* commonly called African bush mango which belongs to the Irvingiaceae family. It is also known as wild mango or bush mango which is different from *Mangifera indica* popularly referred to as mango that belongs to the family Anacardiaceae. African bush mango can be found in many parts of tropical Africa such as Nigeria, Togo, Cameroon, Cote d'Ivoire, Benin and extending to São Tomé et Principe [1]. It is a valuable plant, being source of food, medicines, fodder, dye, building materials and items of commercial interest within and outside Nigeria [1]. Some uses of the different parts of *I. gabonensis* plant to include the fruit pulp that can be used for fruit drink and jam production were highlighted by [2]. Also, the kernel

can be processed into flour; while margarine and cooking oil can be obtained from it. The oil obtained from the kernel apart from being consumed can be used for soap making, cosmetics and pharmaceuticals. The bark is said to be the most important medicinal part of the tree. It has been used in the treatment of diarrhea, dysentery, gastrointestinal and liver disorders, sterility, hernias and urethral discharge. It is believed to be a laxative and a powerful aphrodisiac. The species can also be planted alongside other species to check soil erosion. Perhaps the most important of its benefits in Nigeria and in fact as an export product is its kernels which are dried after extraction and ground to powder to make soup which is considered a delicacy.

Two varieties of *I. gabonensis* have been identified in Nigeria with one having a sweet mesocarp that is edible while the mesocarp of the second variety is not edible due to its bitter taste. The former is known as *I. gabonensis* while the second one is *I. wombolu.* [3] reported that the seed of *Irvingia gabonensis* is rich in lipids and contains appreciable levels of carbohydrates, protein and mineral matter (K and Ca). Nevertheless, as useful as *I. gabonensis* is, its domestication is still very low with the harvest of its fruits obtained predominantly from the wild consequently leading to the rapid depletion of its natural population. Hence, there is the need to support the natural regeneration of this plant by raising its plantation. This would in turn require raising of its seedlings in the nursery to serve as planting stocks. However, this may be an arduous task if the silvical requirements of the species is not known. Therefore, this study is aimed at investigating the seed viability of this species in germination tests having stored the seeds at room temperature for different lengths of time as well as assessing its early seedling growth. This information will be useful to those interested in raising the plant where there might not be access to modern methods of storing seeds to prolong viability. Moreover, [1] and [4] categorized *I. gabonensis* seeds as recalcitrant while [2] categorized it as orthodox. This seeming contradiction has implications on its seed storage.

2. MATERIAL AND METHODS

2.1 Location of the Experimental Site

The experiment was carried out at the nursery site of Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti (EKSU). EKSU is located on latitude 7.7420^{o}N and longitude 5.2580^{o}E in the rain belt at an elevation of 250m above sea level. Ekiti State enjoys tropical climate with two distinct seasons. These are the rainy season (April–October) and the dry season (November–March). Temperature ranges between 21°C and 28°C with high humidity. The south westerly wind and the northeast trade wind blow in the rainy and dry (Harmattan) seasons respectively. Tropical forest exists in the south, while savanna occupies the northern peripheries.

The soils derived from the basement complex rocks are mostly well drained, having a medium to fine texture. The soils of Ekiti State fall into two main association classifications according to Smith and Montgomery. These are Egbeda I Association and Iwo Association. Under the FAO/UNESCO classification, they are Orthic and Plinthic Luvisols, respectively. The former is of high agricultural value for tree crops especially cocoa. The latter is found to the north of the state and classified as Ekiti series. The soils here are skeletal in nature and of comparatively recent origin. Both soil types are of high value for arable crops.

2.2 Germination of *Irvingia gabonensis* Seeds under Different Lengths of Storage and Pretreatments

Fresh mature fruits of *Irvingia gabonensis* were purchased from Bisi market at Ado-Ekiti. The fruits of *Irvingia gabonensis* were given to interested individuals who ate the pulp and returned the seeds. Two hundred (200) seeds of *Irvingia gabonensis* were subdivided into five parts and these were subjected to different lengths of storage. The lengths of storage are fresh (no storage), 7 days storage, 14 days storage, 21 days storage and 28 days storage represented as LS1, LS2, LS3, LS4 and LS5 respectively. Storage was done at room temperature on laboratory desk.

Seeds under the different lengths of storage were subjected to different pretreatments. The pretreatments adopted for overcoming seed dormancy are control (no pretreatment), soaking in water at room temperature, soaking in hot water and scarification represented as PT1, PT2, PT3 and PT4 respectively. Scarification was achieved by rubbing the distal part of the seed opposite the hilum on sand paper. For hot water, water was allowed to boil to 100^{o}C before soaking the seeds in it and this hot water was allowed to cool with the seeds for about 12 hours. In the case of water at room temperature, seeds were steeped in water for 24 hours before sowing. The seeds subjected to the various pretreatments were then sown in germination trays previously filled with topsoil. Watering was done daily in the morning and germination count was done daily until no further germination was observed for about a week. Germination was taken to have occurred when the plumule emerged above the soil surface. The same procedure was repeated for the seeds under each length of storage.

2.3 Seedling Growth Assessment

Uniformly growing seedlings from the different pretreatments under each length of storage were transplanted into polythene pots previously filled with topsoil. LS5 did not produce sufficient seedlings that could continue into the phase of

seedling growth assessment. The following variables were measured on the seedlings every fortnight for twelve weeks: number of leaves, seedling height and collar diameter.

Seedling height was measured with the use of meter rule from the soil level to the tip of the apical bud. The measurement was in cm. Furthermore, seedling collar diameter was measured with the aid of vernier caliper at the point where shoot starts just above the soil level. The measurement was in cm. Number of leaves were counted at every assessment period.

Randomized Complete Block Design (RCBD) was the experimental design for this study. The data collected were subjected to two-way analysis of variance at 5% probability level. Duncan's multiple range test was used to separate the means that were significantly different while descriptive statistics was also used.

3. RESULTS

3.1 Germination of *Irvingia gabonensis* Seeds

3.1.1 Germination of seeds sown fresh using different pretreatments

Table 1 shows the germination of *I. gabonensis* under the different lengths of storage and pretreatments. Germination began 19 Days after Sowing (DAS) under PT2 and was completed on 22 DAS with 100% germination percentage. Similarly, germination began 20 DAS under PT1 and ended at 27 DAS with 90% germination percentage. Likewise under PT4, germination started on 21 DAS and got completed on 24 DAS with a germination percentage of 100%. However, no seedling emerged under PT3 throughout the duration of the experiment. Figure 1 shows the mean germination rate of *I. gabonensis* seeds under the different pretreatments.

3.1.2 Germination of seeds sown after 7 days of storage subjected to different pretreatments

Onset of germination was observed in both PT1 and PT4 at 23 DAS but germination began in PT2 on 24 DAS. Nevertheless, germination was completed in PT1, PT2 and PT4 at 29 DAS giving germination percentages of 90%, 90% and 80% respectively (Figure 2). No germination occurred under PT3 till the experiment was terminated.

3.1.3 Germination of seeds sown after 14 days of storage subjected to different pretreatments

Germination was observed in both PT1 and PT4 on 26 DAS whereas germination began on 27 DAS for PT2. Nonetheless, germination was completed on 30 DAS in PT1, PT2 and PT4 with germination percentages of 60%, 90% and 60% respectively. Germination percentage was 0% under PT3 (Figure 3).

Table 1: Mean germination percentage of *Blighia sapida* seeds subjected to different lengths of storage and pretreatments

Lengths of Storage	Germination Percentage (%)				Onset of Germination (DAS)				End of Germination (DAS)			
	PT1	PT2	PT3	PT4	PT1	PT2	PT3	PT4	PT1	PT2	PT3	PT4
LS1	90	100	0	100	20	19	0	21	27	22	0	24
LS2	90	90	0	80	23	24	0	23	29	29	0	29
LS3	60	90	0	60	26	27	0	26	30	30	0	30
LS4	40	80	0	50	31	29	0	29	33	38	0	36
LS5	50	30	0	0	32	29	0	0	35	34	0	0

3.1.4 Germination of seeds sown after 21 days of storage subjected to different pretreatments

Seedling emergence was observed under PT2 and PT4 on 29 DAS while it was completed in PT2 at 38 DAS with a germination percentage of 80% whereas germination ended under PT4 at 36 DAS giving a percentage of 50%. Also, germination began in PT1 on 31DAS and was completed on 33 DAS with a percentage of 40%. Germination did not occur under PT3 till the experiment was over (Figure 4).

3.1.5 Germination of seeds sown after 28 days of storage subjected to different pretreatments

Germination began on 29 DAS in PT2 and was completed at 34 DAS with a germination percentage 30%. Also, seedling emergence began on 32 DAS in PT1 and ended on 35 DAS giving a germination percentage of 50%. No germination was observed in both PT3 and PT4 till the experiment was terminated (Table 1).

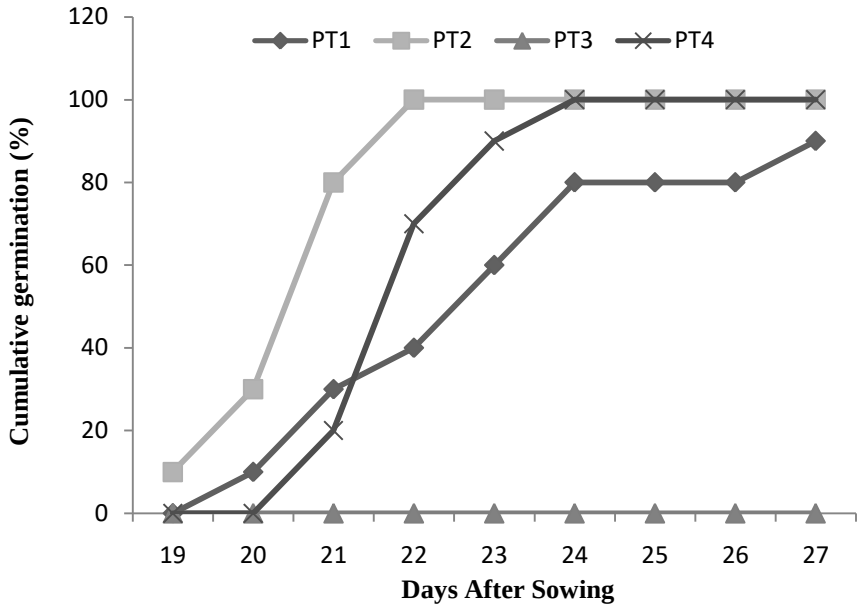

Figure 1: Mean Germination Rate of *Irvingia gabonensis* Seeds Sown Fresh under Different Pretreatments

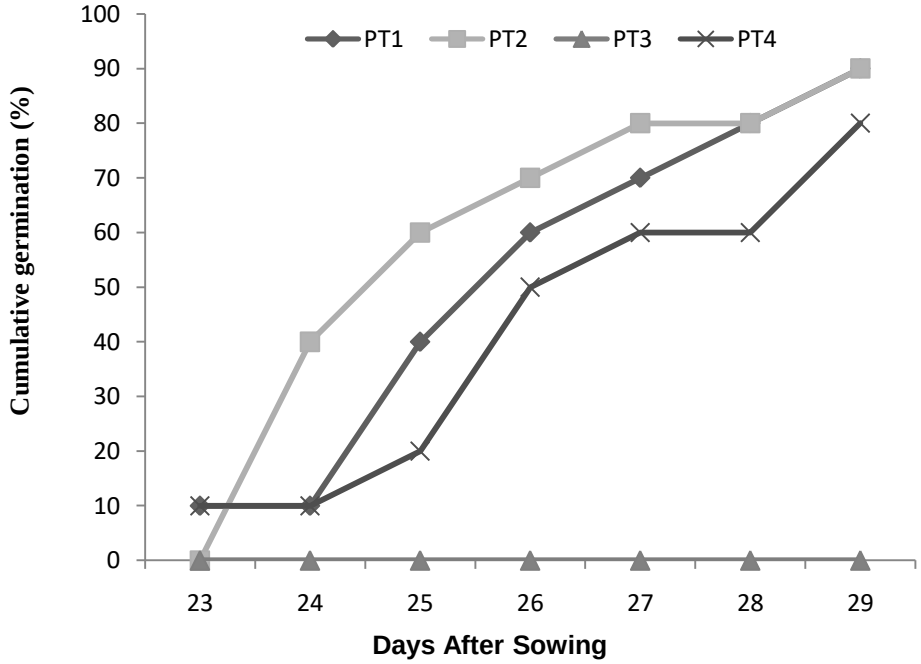

Figure 2: Mean Germination Rate of *Irvingia gabonensis* Seeds Sown after 7 Days Storage using Different Pretreatments

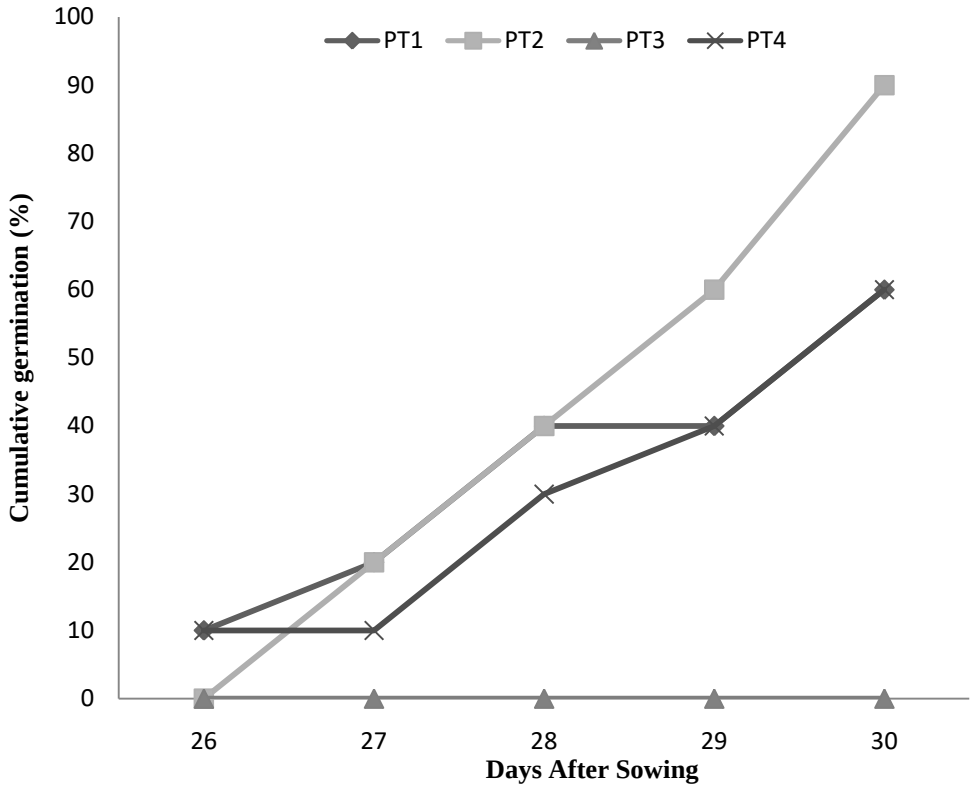

Figure 3: Mean Germination Rate of *Irvingia gabonensis* Seeds Sown after 14 Days Storage using Different Pretreatments

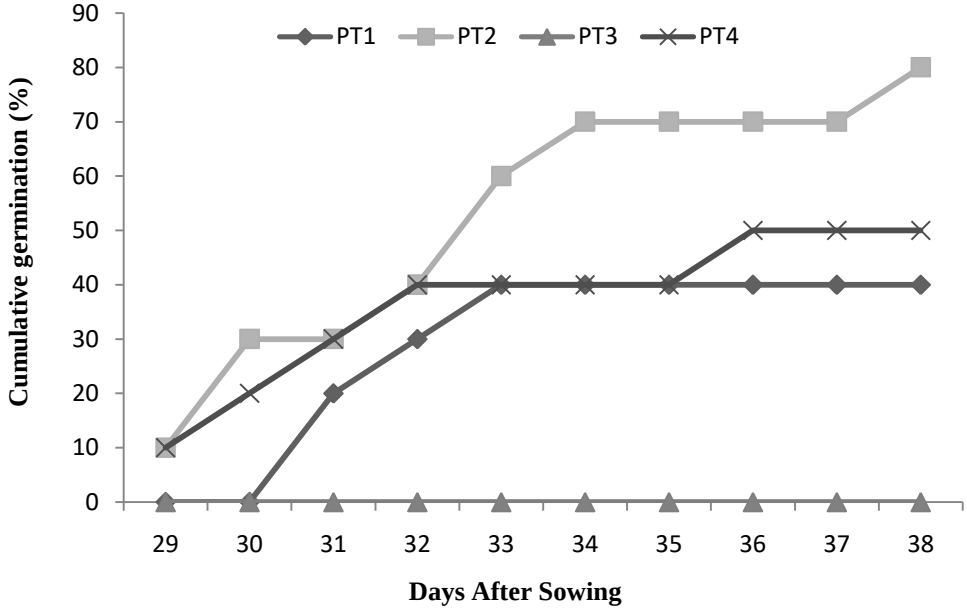

Figure 4: Mean Germination Rate of *Irvingia gabonensis* Seeds Sown after 21 Days Storage using Different Pretreatments

3.2 Seedling Growth of *Irvingia gabonensis*

3.2.1 Seedling Height

Analysis of Variance (ANOVA) result for seedling height is shown in Table 2. There was no significant difference ($p>0.05$) from 2 weeks to 8 weeks among the lengths of storage (LS). However, significant difference ($p\leq0.05$) was observed at 10 weeks and 12 weeks. Moreover, when Duncan's Multiple Range Test (DMRT) was used to separate the mean height

values of LS at both 10 weeks and 12 weeks (Table 3), it was observed that LS1 was not significantly different from LS2 and LS4. Also, LS2 was significantly different from both LS3 and LS4. Furthermore, LS3 and LS4 were not significantly different from each other. Nevertheless, the highest mean height value of 23.94cm was obtained at 10 weeks under LS2 followed by 22.85cm under LS1 at 12 weeks while LS1 produced the least value of 19.73cm at 2 weeks (Table 3).

Table 2: Analysis of variance for mean height under different lengths of storage across assessment period

SV	DF	MS	F	p-level
LS at 2 weeks	3	7.08	3.35	0.08
LS at 4 weeks	3	5.56	3.25	0.08
LS at 6 weeks	3	6.54	3.91	0.06
LS at 8 weeks	3	4.80	2.32	0.15
LS at 10 weeks	3	8.06	6.12	0.02*
LS at 12 weeks	3	6.49	4.94	0.03*

*****Indicates significance at p≤0.05
Where SV = Source of Variation, DF = Degree of Freedom, MS = Mean Square, F = F calculated, p-level = Probability level and LS = Lengths of Storage

Table 3: Mean height values of *I. gabonensis* seedling for the lengths of storage across the assessment period

Assessment periods (weeks)	LS1 (cm)	LS2 (cm)	LS3 (cm)	LS4 (cm)
2	20.97	23.21	19.73	20.22
4	21.21	23.02	19.87	20.48
6	22.21	23.55	20.25	20.82
8	22.58	23.55	20.39	20.88
10	22.78^{ab}	23.55^{a}	20.44^{c}	20.88^{bc}
12	22.85^{ab}	23.94^{a}	20.54^{c}	20.88^{bc}

NOTE: Means with the same letter in each row are not significantly different (p > 0.05).
Row without superscripts did not indicate significance (p > 0.05) at that assessment period.

3.2.2 Collar Diameter

There was significant difference for collar diameter under the different lengths of storage at 2 weeks and 4 weeks as revealed by ANOVA (Table 4) whereas no other significant difference was observed from 6 weeks to 12 weeks. When DMRT was used to separate the means that were significantly different at 2 weeks (Table 5), it showed that LS1 was not significantly different from each other but different from LS3 and LS4 whereas the LS3 and LS4 were not significantly different from each other. Furthermore at 4 weeks, LS1, LS2 and LS3 were not significantly different from one another but were different from LS4 (Table 5). Moreover, the highest mean collar diameter value of 0.44cm was obtained under LS4 from 6 weeks to 12 weeks closely followed by 0.43cm still under LS3 whereas the least value of 0.38cm was obtained under LS1, LS2 and LS4 at 2 weeks.

Table 4: Analysis of variance for mean collar diameter under different lengths of storage across assessment period

SV	DF	MS	F	p-level
LS at 2 weeks	3	0.00	4.33	0.04*
LS at 4 weeks	3	0.00	4.62	0.04*
LS at 6 weeks	3	0.00	1.50	0.29
LS at 8 weeks	3	0.00	1.95	0.20
LS at 10 weeks	3	0.00	1.92	0.21
LS at 12 weeks	3	0.00	1.92	0.21

*****Indicates significance at p≤0.05
Where SV = Source of Variation, DF = Degree of Freedom, MS = Mean Square, F = F calculated, p-level = Probability level and LS = Lengths of Storage

Table 5: Mean collar diameter values of *I. gabonensis* seedling for the lengths of storage across the assessment period

Assessment	LS1	LS2	LS3	LS4

periods (weeks)	(cm)	(cm)	(cm)	(cm)
2	0.38[b]	0.38[b]	0.42[a]	0.38[a]
4	0.40[a]	0.40[a]	0.43[a]	0.40[b]
6	0.41	0.40	0.44	0.41
8	0.41	0.40	0.44	0.41
10	0.41	0.40	0.44	0.41
12	0.41	0.40	0.44	0.41

NOTE: Means with the same letter in each row are not significantly different ($p > 0.05$).
Row without superscripts did not indicate significance ($p > 0.05$) at that assessment period.

3.2.3 Number of Leaves

ANOVA did not indicate significance in mean number of leaves for the lengths of storage across assessment period i.e. from 2 weeks to 12 weeks (Table 6). Also, when the mean values were considered for the different lengths of storage across assessment period, it was 4 from the start of the experiment till it was terminated (Table 7).

Table 6: Analysis of variance for mean number of leaves under different lengths of storage across assessment period

SV	DF	MS	F	p-level
LS at 2 weeks	3	0.08	1.00	0.44
LS at 4 weeks	3	0.08	1.00	0.44
LS at 6 weeks	3	0.08	1.00	0.44
LS at 8 weeks	3	0.22	1.33	0.33
LS at 10 weeks	3	0.22	1.33	0.33
LS at 12 weeks	3	0.22	1.33	0.33

*****Indicates significance at $p \leq 0.05$
Where SV = Source of Variation, DF = Degree of Freedom, MS = Mean Square, F = F calculated, p-level = Probability level and LS = Lengths of Storage

Table 7: Mean Number of Leaves of *I. gabonensis* Seedling for the Lengths of Storage across the Assessment Period

Assessment periods (weeks)	LS1 (cm)	LS2 (cm)	LS3 (cm)	LS4 (cm)
2	4	4	4	4
4	4	4	4	4
6	4	4	4	4
8	4	4	4	4
10	4	4	4	4
12	4	4	4	4

4. DISCUSSION

4.1 Germination of *Irvingia gabonensis* Seeds subjected to Different Lengths of Storage

Germination was observed in all the lengths of storage from freshly sown seeds to seeds stored for 28 days but germination percentages across the lengths of storage varied. Generally, there was a decline in germination percentage as length of storage increased. Also, days to germination increased with increasing length of storage as well as time taken for germination to be completed. This result is in agreement with that of [5] where seeds of *Blighia sapida* that were sown fresh had the highest germination percentage and this reduced with increasing length of storage. Similarly, [6] observed that *Dacrodes edulis* seeds sown fresh produced the highest germination percentage while this also decreased with increasing length of storage at room temperature. The fact that seeds of *I. gabonensis* germinated with increasing lengths of storage is an indication that desiccation does not affect its seeds because they are orthodox. [2] already reported seed storage behaviour of *I. gabonensis* as orthodox. Although, some authors [1; 4] reported the *I. gabonensis* seeds as recalcitrant, this study proves it otherwise since the seeds still germinated after storage for about four weeks. It was already opined that seed deterioration and loss of viability is a natural phenomenon occurring during storage [7; 8]. This might have been due to loss of moisture that would have occurred as a result of storage at room temperature. Storage at room temperature in Nigeria is still very important as this will make farmers to know the length of time their freshly

collected seeds can be kept without jeopardizing the viability since fruit collection time may not coincide with propagation period. Likewise, seed storage in other media is still very challenging due to erratic power supply.

4.2 Germination of *Irvingia gabonensis* Seeds subjected to Different Pretreatments

The various pretreatments showed variations in germination percentage. Seeds soaked in water at room temperature produced the highest germination closely followed by seeds under control whereas seeds soaked in hot water did not germinate at all till the experiment was concluded. This result is similar to that obtained by [5] whereby seeds of *B. sapida* seeds soaked in water at room temperature produced the highest germination percentage followed by the seeds that were not pretreated (control). Also, the fact that seeds pretreated with hot water did not germinate agrees with the work of [5] where seeds of *B. sapida* soaked in hot water did not germinate at all throughout the period of the experiment. The reason for the inability of hot water to aid germination in seeds of *I. gabonensis* can be attributed to damage to the embryo as a result of the exposure time. Contrariwise, [9] reported hot water treatment as effective in breaking dormancy in *Albizia lebbeck* seeds whereas soaking such seeds in cold water did not favour germination. Also, germination rate (the time taken for germination to occur) increased with increasing lengths of storage under each pretreatment. [10] reported that hot water aided germination percentage and rate for some fast growing tropical tree species although exposure time varied for the different species. Seeds of *I. gabonensis* may not really require any specific treatments because seeds that were untreated in this study favourably competed with treated seeds in terms of germination and percentage rate. This result is in agreement with [4] where the recommended that *I. gabonensis* seeds do not require specific treatments for optimizing germination.

4.3 Seedling Growth of *Irvingia gabonensis*

Seedling growth variables were not influenced by lengths of storage based on the results of this study. This agrees with [11] who reported that different lengths of storage had little or no effect on seedling growth of *Blighia sapida*. Likewise, [12] found no significant differences in seedling survival or relative growth rates for seedling height and number of leaves obtained from *Mimosa foliolosa* seeds that were stored for different lengths of time. The fact that assessment period did not also significantly influence the seedling growth of *I. gabonensis* confirmed the report of [1] that growth in young plants of *I. gabonensis* is very slow.

5. CONCLUSION

Seeds of *Irvingia gabonensis* can be successfully stored for up to four weeks at room temperature without significant loss in viability although germination percentage would reduce with increasing length of storage. Soaking of *I. gabonensis* seeds in water at room temperature and scarification produced good germination across the different lengths of storage and can be adopted for overcoming dormancy in *I. gabonensis* seeds. Pretreating seeds of *I. gabonensis* with hot water should be avoided altogether. Moreover, *I. gabonensis* seeds can be raised without any form of pretreatment because untreated seeds in this study produced good germination even under varying lengths of storage. Furthermore, *I. gabonensis* seedlings were not significantly affected by lengths of storage because the different variables assessed did not show marked significance throughout the assessment period.

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