SEED GERMINATION AND EARLY GROWTH TRIAL OF *Ceiba pentandra* (L. Gaertn)

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Abstract
Ceiba pentandra Gaertn may fail to germinate under favourable environmental conditions and are therefore said to exhibit some degree of dormancy. A field experiment was carried out to investigate the germination trial of *Ceiba pentandra* and its early growth. The study was laid in a 3 x 3 factorial experiment in a completely randomized design (CRD) with a total of 9 treatment combinations replicated 20 times making a population of 180 test samples. The result showed that seeds sun-dried for 5hours for 5 days had the highest mean germination of 87.23±25.25% while seeds soaked in water for 24 hours and control, had mean germination of 81.66±27.14% and 78.58±27.11% respectively. The result of growth variables revealed that, *Ceiba pentandra seedlings* were 33.24±2.63cm height, 1.65±1.31cm collar girth, 0.52±0.40cm collar diameter, 9.7±4.08cm^2 leaf area and 25.99±15.39 number of leaf within a period of 3 months of field work. The results of ANOVA showed that, the effect of both germination media and seeds pretreatments were highly significant on collar girth, plant height, leaf area and number of leaves of *Ceibe pentandra* at $p<0.01$ probability level. There was also a positive significant correlation between plant height and collar girth (0.528*) at $p<0.05$ probability level. While the result of regression analysis on the effects of growth variables on seedlings height had coefficient of determination (R^2 = 87.5); meaning that, the assessed growth variables had about 87.5% effects on the seedlings height of *Ceiba pentandra*. It also showed that top soil supported rapid early growth of *Ceiba pentandra* seedlings better than river sand and sawdust. However, further research activities on seed pretreatment of *Ceiba pentandra* should be intensified to improve the result of his work.

Keywords: *Ceiba pentandra*, germination, growth, seedlings, pre-treatment
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Introduction

Ceiba pentandra (L.) Gaertn is commonly known as Kapok tree of silk cotton trees. It is a tropical tree of the order Malvales and the family malvaceae which was previously separated from the family Bombacaceae (Sofomora, 1993). *Ceiba pentandra* is a fast growing indigenous tree species to West Africa and also found in South America (Baker, 1965 and FPIB, 1994). It is an emergent tropical forest tree species that can grow up to 60 m height (Gribrel *et al*., 1999). The wood is very light and is used for preparation of plywood (Attah, 2005), packaging, lumber, light construction, pulp and paper products, match splint, canoes, veneer, block boards, furniture, boxes and aircraft modeling (Sahid and Zeven, 2003). The fruit is collected for the valuable kapok floss and used for stuffing

pillows, mattresses, cushions, life jackets, lifeboats, insulating; refrigerators and cold-storage (Anon, 1986). The seed contains 20-25 percent non-drying oil, used as a lubricant and in soap manufacturing (Sarkiyayi *et al.,* 2009). *Ceiba pentandra* is known to be an excellent source of nutrient such as minerals, vitamins and very high moisture content of 60 to 83g/100g (FAO, 1968). The young leaf of *Ceiba pentandra* is extremely high in fibre content (Oladejo, 2009). Soluble dietary fibres have health-promoting properties as they have been implicated in the lowering of plasma and liver cholesterol concentrations (Behall, 1986). The high value of carbohydrate and protein suggest that the nutritional quality of the *Ceiba pentandra* leaf is high and this may be a veritable tool for body nourishment (Antia *et al*., 2006).

In Nigeria, the leaves are used as an alternative laxative and the infusion is given as a cure for colic in man and in livestock (Burkill, 2000). The young leaves are sometimes cooked and eaten in West Africa as a soup herb (Burkill, 2005). The seeds of *C. pentandra* provide important food resources to small mammalian wildlife (rodents), and it is an important source of local human medicines (Friday *et al.,* 2011). Apparently, the species provides important roosting sites for some mammalian species (bats), insects and pollinator bees as well as several bird species (Singaravelan and Marimuthu, 2004).

Temperature has been observed to strongly influence seed germination of tropicual forest trees, including *C. pentandra* (Pearson *et al.,* 2002). It is worth noting that the conditions leading to the germination of seeds may be complex given that several factors including environmental (e.g. temperature, water), seed attributes e.g. size, weight and shape (Dileep *et al.,* 1994), physiological (Kandya, 1990) and seed predation (Orrock *et al*., 2006) singly or together may affect seed viability and subsequent seed germination ability. Seed pre-treatments have been used to describe ways of treating seeds to increase their vigor for germination.

In view of the potentials of *Ceiba pentandra*, its germination and growth rate without seed pretreatment is very slow. Sometimes seeds of *Ceiba pentandra* may fail to germinate under favourable environmental conditions and are therefore said to exhibit some degree of dormancy. Due to excessive temperature around Guinea Savannah Zone, *Ceiba pentadra* seeds get damaged before the pods naturally dehiscent. This study therefore, is to investigate seed germination trial of *Ceina pentandra* and its early growth by using suitable seed pretreatment methods and germination media to raise the species in the nursery. There was an improvement in germination when seeds of *Ceiba pentandra* were pre-treated by scoring lightly and soaking in water for 24 hours (Apetorgbor *et al*., 2003). He said, however, further research activities on seed pretreatment of *Ceiba pentandra* should be intensified to improve the result of his work.

Fruit and Seed Description of *Ceiba pentandra*

Fruit: a leathery, ellipsoid, pendulous capsule, 10-30 cm long, 3-6 cm wide, rarely dehisces on the tree. Capsules split open into 5 valves, revealing a mass of grey woolly hairs in which the 120-175 seeds are embedded (Chinea-Riverra, 1990). While, the **Seed** is usually: black or dark brown, covered with wool. Oil content 20-25%. There are 10,000-45,000 seeds/kg depending on provenance (Gonzales, 1992) (Plate 1).

Propagation and Planting of *Ceiba pentandra*

The seeds are sown in seed beds or in sand boxes in a greenhouse. Fresh seeds normally germinate 85-95%, when pre-treated by scoring lightly and soaking in water for 24 hours or by soaking in boiling water for 5 minutes (Apetorgbor *et al*., 2003). When the first pair of leaves appears and the seedlings are 12-15 cm, the roots are pruned and the seedlings transferred to polybags. The plants are ready for planting in the field 4-6 months after sowing when they are 30-35 cm tall. It is easy to propagate vegetatively by cuttings. Germination is good in sandy soil with temperatures of 20030°C (Lamprecht, 1989). Trees raised from seeds root deeper than those raised from cuttings, but develop slower. Recommended planting distances are 4.5–5 m × 4.5–5 m, with elimination of every second row after 6 years, to arrive at a spacing of 10 m between rows. Seeds may also be sown at about 7 m spacing between trees, with an understorey of crops until the canopy closes, about 5 years after planting. In the first 2 years after planting, vegetation must be cleared periodically around saplings. General tending may be necessary in the following years, by cutting climbers and removing dead and diseased trees. Plantations need not be thinned if planted with 7 m spacing unless intercropped with smaller tree crops (Apetorgbor *et al.,* 2003).

Seed Dormancy and Pretreatment of *Ceiba pentandra*

Germination is the activation of embryo previously either quiescent or dominant (Villiers, 2005). Many seeds do not germinate when placed under conditions regarded as favorable to germination under such conditions; the germination of a seed may be delayed for long periods. Such seed can be said to be viable provided that the embryo is not damaged (Mayer and Poljackoff, 2005), as they can be induced to germinate by various special treatments, such seeds are said to be in a state of dormancy.

Temperature has been observed to strongly influence seed germination of tropical forest trees, including *C. pentandra* (Pearson *et al.,* 2002). It is worth noting that the conditions leading to the germination of seeds may be complex given that several factors including environmental (e.g. temperature, water), seed attributes e.g. size, weight and shape (Dileep *et al*., 1994), physiological (Kandya, 1990) and seed predation (Orrock *et al*., 2006) singly or together may affect seed viability and subsequent seed germination ability. Immersion in boiling water for 1 min and left in tap water for 24 hours has been

reported to improve germination. (Chinea-Riverra, 1990). Seeds pre-treatment have been used to describe ways of treating seeds to increase their vigor for germination.

Growth and Development of *Ceiba pentandra*

Without any pre-treatment seeds germinate slowly (less than 10% within one month after sowing) and germination may continue for 3-4 months. Bush fire may cause simultaneous germination of seeds (Apetorgbor, *et al*., 2003). Growth is relatively fast. Seedlings planted in Ghana were 29 cm tall in 6 weeks after germination and 63 cm after 51 weeks. The annual increases in height and diameter during the first 10 years are about 1.2 m and 3-4 cm, respectively. In forest gaps height growth may be 2 m/year (Gapper and Dolan, 2006). The tree is obligately deciduous, losing its leaves for 10-14 weeks in the dry season, and it usually flowers annually in the leafless period. Leafing and flowering periods are more regular in drier parts of the distribution area; in moister areas, leafing and flowering periods are highly irregular (Lamprecht, 1989). The flowers open at night and are senescent by midday; they are pollinated by bats, but are also visited by moths and bees. The fruits ripen 80-100 days after flowering, the dehiscent types releasing kapok with loosely embedded seeds that are wind-dispersed.

Material and methods

Plus-Tree sellection and seed collection

Ceiba pentandra pods were collected from plus-trees of *Ceiba pentandra* mini-plantation located at Filin-Hutu, Markudi Road, Lafia, Nasarawa State. The pods were collected directly by plucking and hand picking under the trees. The trees were of timber sizes and of good phenotypically. Wildlings were hardly seen around the plantation area (Plate 1).

Plate 1: Pods from *Ceiba pentandra*

Plate 2: Seedlings showing the treatments

Seed Processing
The pods from *Ceiba pentandra* contained silk cotton and seeds that were extracted manually by scarification method. The seeds were embedded in the silk cotton and extracted by shaking or hand picking individual seed. The seeds were tiny but visible to the nicked eye and each pod contains 180 seeds on the average. Seed pretreatment methods used were; 5 minutes oven dried at 65^{o}c, 24 hours soaked in tap water and the control. The reason for using the seed pretreatments is to improve the rate and percentage of germination of *Ceiba pentandra* seeds (Plate 1).

Experimental Site
Field experiment was carried out during the raining season of 2013 at the Forestry and Wildlife Research Farm of Faculty of Agriculture Nasarawa State University, Keffi, Shabu-Lfia Campus (08^{0}35'N, 08^{0}33'E), located in the southern guinea savannah zone of Nigeria with altitude of about 177m above sea level. The mean monthly minimum and maximum temperature ranged is between 20.16^{0}c to 20.50^{0}c and 35.06^{0}c to 36.40^{0}c respectively while the mean monthly relative humidity and rainfall were 74.67% and 168.90mm respectively.

Land preparation
The site was manually cleared, followed by three germination boxes placed on the field, including germination test box. The germination test box was filled with river sand while each of the other three boxes was subdivided into three compartments and randomly filled with three germination media; that is top soil, river sand and saw dust. Field work was conducted under a weaning shed to prevent high impact of sun on seed germination and seedlings growth (Plate 2).

Germination media and seed sowing
This is a wooden structure, filled with 3 germination media. Each box measured (116 x 112 x 15) cm^3 width. The bottoms of the boxes were sealed with cellophane to prevent direct contacts with soil. The boxes were systematically constructed to allow water drainage. Soil is a medium for seedling growth, three germination media; top soil, river sand and saw dust were used to assess seed germination and seedling growth of *Ceiba pentandra*. It serves as nutrients pull for plant uptake and maintenance of physiological functioning of seedlings. The method of seed sowing used was by broadcast. The seeds were evenly broadcast over the germination media. While, the variable measured were soil temperature and soil moisture content, collar girth, seedling height, leaf area, number of leaf and dry matter (Plate 2).

Dry Matter assessment
Nine seedlings were randomly selected from each treatment, tagged, enveloped and put into oven at 65^{o}c for 48 hours to determine the weight loss and moisture content of the

biomass. The weights of the various seedlings were determined by using digital weighing balance. The wet weight of the biomass was determined and subtracted from the oven dried weight to get the weight loss. Subsequently, the moisture content was calculated by subtracting dried weight from wet weight of the biomass, divided by dried weight and multiplied by hundred.

Data analysis

The study was laid in a 3 x 3 factorial experiment in a Completely Randomized Design (CRD) with a total of 9 treatment combinations replicated 20 times making a population of 180 test samples in order to facilitate the interpretation of the main treatment effects. Treatments were analyzed with respect to 3 germination media and 3 seed pre-treatment methods. Analysis of variance was performed on the data to show the comparative performance of each treatment with others, where significant difference were found, Duncan's Multiple Range Test (DMRT) was applied on the bases of 3 germination media and 3 seed pre-treatment methods in locating where the significant differences occurred among treatment means of seed germination and seedlings_growth variables while One Way ANOVA was used to analyze the moisture content of the soil. Correlation analysis was used to access the magnitude and the degree of relationship between the selected variable while the plant height of *Ceiba pentandra* was predicted using linear regression analysis described by using linear regression thus:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \ldots + b_nx_n + \mu \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where Y = (dependent variable) the plant height, a = intercept, b_1--b_n, = regression parameters, x_1 ---x_n = independent variables

The coefficient of determination (R^2) and standard error of estimate (mean square error) were determined to know the proportion of variation explain by the regression equation.

Results

Result of mean values on Seed Germination test of *Ceiba pentandra*

Result of showed that *Ceibe pentandra* sowed on top soil had the highest mean seed germination of 87.20±27.63% while river sand and saw dust had mean germination of 81.66±27.14% and 78.58±27.11%. The result also showed that seeds sun-dried for 5hours for 5 days had the highest mean seed germination of 87.23±25.25% while seeds soaked in water for 24 hours and control (no pretreatment) had mean germination of 81.66±27.14% and 78.58±27.11% respectively. There was a progressive increase in the seed germination from 3days up to 39 days after planting when no new germination was observed (Table 1). The results of ANOVA showed that, the effect of both germination media and seeds pretreatments was not significant on seed germination of *Ceibe pentandra* at $p<0.05$ probability level (Table 2). The non-variation in the values of seed germination is

different from (Apetrogbor, *el, al.,* 2003) who observed that seed pretreatment has more effect on seed germination than that of germination media.

Mean Values of Seedlings Growth Variables as influenced by germination media and pre-treatment methods

Plant height

The results showed that, seedlings sowed on top soil had the highest mean plant height of 68.94±1.37cm while on river sand and saw dust had mean heights of 26.84±1.08cm and 23.56±5.90cm respectively. The result also revealed that seeds sun-dried for 5hours for 5 days had the highest mean plant height of 45.52±1.17cm while seeds soaked in water for 24 hours and control (no pretreatment) had mean height of 39.93±1.26cm and 33.96±1.14cm respectively. There was a progressive increase in the plant height with mean of 9.70±1.80cm after 4weeks, 21.11±8.75cm after 8weeks and 29.61±1.23cm in 12 weeks after planting (Table 3).

Collar girth

The results showed that, River sand had the highest mean collar girth of 1.49±0.54cm while top soil and saw dust had mean collar girth of 1.49±0.54cm and 1.06±0.29cm respectively. The result also revealed that seeds sun-dried for 5hours for 5 days had the highest collar girth of 2.39±2.95cm while seeds soaked in water for 24 hours and control (no pretreatment) had mean collar girth of 1.31±0.54cm and 1.27±0.45cm respectively. There was also a progressive increase in the collar girth with mean of 1.87±1.40cm after 4weeks, it decreased to 1.45±0.30cm after 8weeks and increased to 1.65±0.45cm in 12 weeks after planting (Table 3).

Leaf area

The results showed that, top soil had the highest mean leaf area of 12.30±3.40cm^2 while river sand and saw dust had mean leaf area of 8.80±4.86cm^2 and 7.98±3.15cm^2 respectively. The result also revealed that seeds sun-dried for 5hours for 5 days had the lowest leaf area of 9.39±4.75cm^2, seeds soaked in water for 24 hours had 9.96±4.01cm^2 while the control (no pretreatment) had the heights mean leaf area of 10.07±4.07cm^2. There was also a progressive increase in the leaf area with mean of 9.83±3.53cm^2 after 4weeks, it decreased to 8.54±3.89cm^2 after 8weeks and increased to 10.74±5.07cm^2 in 12 weeks after planting (Table 3).

Number of leaf

The results showed that, top soil had the highest mean number of leaf of 34.97±19.950 while river sand and saw dust had mean number of leaf of 27.70±18.15 and 15.25±9.90 respectively. The result also revealed that seeds soaked in water for 24 hours had the heights numbers of leaf of 27.64±18.41, this was followed by seeds sun-dried for 5hours

for 5 days with 26.92±18.15. While the control (no pretreatment) had the lowest mean number of leaf of 23.47±18.87. There was a progressive increase in the number of leaf with mean of 9.17±3.70 after 4weeks, it decreased to 27.89±14.10 after 8weeks and 40.97±17.34 in 12 weeks after planting (Table 3). The results of ANOVA showed that, the effect of both germination media and seeds pretreatments were highly significant on collar girth, plant height, leaf area and number of leaves of *Ceibe pentandra* at $p<0.01$ probability level. Also, the interaction of both germination media and seeds pretreatments were highly significant on collar girth, plant height, leaf area and number of leaves of *Ceibe pentandra* at $p<0.01$ probability level (Table 4).

Mean values on Biomass assessment of *Ceiba pentandra*

The results of biomass assessment of *Ceiba pentandra* showed that, the seedlings planted on saw dust had the highest mean moisture content of 352.23±44.37% while seedlings on top soil and river sand had moisture content of 263.31±62.14% and 173.92±68.78% respectively. The result also revealed that, seedlings from the seeds sun-dried for 5hours for 5 days had the highest moisture content of 330.38±45.70%, this was followed by seedlings from the seeds soaked in water for 24 hours with 324.78±83.31%. While the control (no pretreatment) had the lowest mean moisture content of 264.99±73.42%, (Table 5). The results of ANOVA showed that, the effect of germination media was significant on seedlings moisture content of *Ceiba pentandra* at $p<0.05$ probability level. While, the effect of seeds pretreatments was not significant on seedlings moisture content of *Ceiba pentandra* at $p<0.05$ probability level (Table 6).

Result of correlation and regression analysis of seedling growth variables

The result of correlation analysis shows that, there was a positive significant relationship between seedling height and number of leaf (0.918**). There was also a positive significant correlation between plant height and collar girth (0.528*) at $p<0.05$ probability level. This means that as the height increases, it is expected that the numbers of leaf of the seedlings also increase, this also indicates that plant height depend largely on collar girth (Table 8). While the result of regression analysis on the effects of growth variables on seedlings height had coefficient of determination ($R^2 = 87.5$); meaning that, the assessed growth variables had about 87.5% effects on the seedlings height of *Ceiba pentandra* (Table 9).

Table 1: Mean values on Seed Germination test of *Ceiba Pentandra*

S/N	Sources of Variation	Sample Size	Mean	Coefficient of Variation %
1.	**Germination media**			
	Top soils	60	78.58±27.11[a]	54
	River sand	60	81.66±27.14[a]	54
	Saw dust	60	87.20±27.63[a]	52
2.	**Treatment**			
	Control	60	78.58±27.11[a]	54
	24 hours soaked in water	60	81.66±27.14[a]	54
	5hrs sun-dried for 5days	60	87.23±25.25[a]	48
3.	**Duration**			
	3 days	180	9.55±2.96[a]	30
	6 days	180	15.66±2.12[b]	13
	9 days	180	22.44±5.85[c]	26
	12 days	180	28.55±5.45[d]	19
	15 days	180	34.55±5.98[e]	17
	18 days	180	39.44±6.00[f]	15
	21 days	180	48.55±5.43[g]	11
	24 days	180	55.44±6.26[h]	11
	27 days	180	73.33±5.26[i]	7
	30 days	180	77.11±5.25[j]	6
	33 days	180	80.11±4.16[k]	5
	36 days	180	84.44±4.36[l]	5
	39 days	180	87.11±5.08[m]	5

Figures with the same alphabet in the same column are not significantly different.

Table 2: Result of Analysis of Variance on Seed Germination

Sources of Variation	sum of Squares	Df	Mean Square	F	Sig	R^2
Germination media	172.76	2	86.385	0.111	0.895[ns]	
Treatment	181.12	2	90.564	0.116	0.891[ns]	
Germ.media*treatment	370.87	4	92.718	0.119	0.976[ns]	
Error	84418.46	108	781.652			
Total 383371.00		117				0.009

** = highly significant at 1% probability level, * = significant at P< 0.05 and [ns] = Not significant.

Table 3: Mean values of Seedlings Growth Variables as influenced by germination media, treatments and duration

S/N	Sources of Variation	Height (cm)	Collar girth (cm)	Collar diameter (cm)	Leaf area (cm^2)	Number of leaf
	Germination media					
1.	Top soil	68.94±1.37^c	1.49±0.54^b	0.47±0.17^b	12.30±3.40^c	34.97±19.95^c
2.	River sand	26.84±1.08^b	2.41±2.95^c	0.76±0.93^c	8.80±4.86^b	27.70±18.15^b
3.	Saw dust	23.56±5.90^a	1.06±0.29^a	0.33±0.09^a	7.98±3.15^a	15.25±9.90^a
	Treatment					
1.	Control	33.96±1.14^c	1.27±0.45^a	0.40±0.14^a	10.07±4.07^b	23.47±18.87^b
2.	24 hours soaked in water	39.93±1.26^b	1.31±0.54^b	0.41±0.17^c	9.96±4.01^a	27.64±18.41^c
3.	5hrs sun-dried for 5days	45.52±1.17^a	2.39±2.95^c	0.76±0.94^b	9.08±4.75^c	26.92±18.15^a
	Duration					
1.	4 weeks	9.70±1.80^a	1.87±3.40^c	0.59±0.98^c	9.83±3.53^b	9.17±3.70^a
2.	8 weeks	21.11±8.75^b	1.45±0.30^a	0.46±0.09^a	8.54±3.89^a	27.89±14.10^b
3.	12 weeks	29.61±1.23^c	1.65±0.45^b	0.52±0.14^b	10.74±5.07^c	40.97±17.34^c
	Grand means	33.24±2.6	1.65±1.31	0.52±0.40	9.7±4.0	25.99±15.39

Figures with the same alphabet in the same column are not significantly different

Table 4: Analysis of Variance for growth variables assessed on *Ceiba pentandra* seedlings

		Collar girth		**Height**		**Leaf count**		**Leaf area**	
Sources of Variation	**df**	**F**	**sig.**	**F**	**sig.**	**F**	**sig.**	**F**	**sig.**
Germ. media	2	653.248	0.000**	381.666	0.000**	253.785	0.000**	108.10	0.000**
Treatment	2	554.170	0.000**	16.1888	0.000**	12.291	0.000**	5.90	0.000**
Week	2	60.156	0.000**	855.952	0.000**	659.004	0.000**	24.54	0.000**
Germ. media* treatment	4	477.908	0.000**	27.421	0.000**	13.333	0.000**	20.79	0.000**
Germ. media*week	4	499.673	0.000**	72.043	0.000**	37.602	0.000**	35.55	0.000**
Treatment*week	4	550.479	0.000**	5.661	0.000**	2.224	0.000**	12.83	0.000**
Germ. Med*treatment*week	8	579.016	0.000**	33.983	0.000**	8.770	0.000**	9.41	0.000**
Error	513								
Total	540								
R^2			**0.963**		**0.863**		**0.807**		**0.552**

Note: ** = highly significant at 1% probability level, * = significant at $p<0.05$, ns = not significant.

Table 5: Mean Values of Biomass Assessment on *Ceiba pentandra* seedlings

S/N	Sources of variation	Wet weight(g)	Dry weight (g)	Moisture content (m^3)	Percentage MC (%)
	Germ. media				
1.	Top soil	89.86±58.29[a]	19.87±12.40[a]	69.99±46.05[a]	352.23±44.37[a]
2.	River sand	45.39±32.89[b]	16.57±11.07[b]	28.82±22.17[b]	173.92±68.78[b]
3.	Saw dust	34.66±60.61[c]	9.54±10.82[c]	25.11±19.93[c]	263.31±62.14[c]
	Treatment				
1.	Control	59.13±60.97[a]	15.89±14.45[a]	43.23±46.75[a]	264.99±73.42[a]
2.	24 hours soaked in water	71.93±40.14[a]	18.07±12.49[a]	53.86±28.69[a]	324.78±83.31[a]
3.	5hrs sun-dried for 5days	78.84±57.85[a]	18.01±11.82[a]	60.83±46.15[a]	330.38±45.70[a]
	Grand means	74.96±55.32	19.21±14.21	55.74±41.53	336.05±74.93

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Figures with the same alphabet in the same column are not significantly different

Table 6: Result of Analysis of Variance of *Ceiba pentandra* Biomass

Dependent Variable	Sources of Variation	Sum of squares	Df	Mean Square	f	Sig	R^2
	Germ. media	3818.22	2	1909.11	0.74	0.009**	
Wet weight	Treatment	1200.22	2	600.11	0.23	0.79[ns]	
	Germ. media *treatment	16603.15	4	415.079	1.62	0.25[ns]	
	Error	22966.53	9	2551.83			
	Total	44588.14	17				0.726
MC	Germ. media	28358.85	2	14179.42	3.40	0.004**	
	Treatment	15762.91	2	1564.87	1.89	0.20[ns]	
	Germ. media *Treatment	6259.48	4	7881.45	0.37	0.82[ns]	
	Error	37498.46	9	4166.49			
	Total	87879.71	17				0.260

** = highly significant at 1% probability level, * = significant at P< 0.05, and [ns] = Not significant.

Table 7: Result of correlation analysis of growth variables of *Ceiba pentandra*

	week	Height	Colar girth	Leaf area	Number of leaf
Week	1				
Height	0.678**	1			
Colar girth	-0.050	0.060	1		
Leaf area	0.087*	0.526**	-0.298**	1	
Number of leaf	0.704**	0.918**	0.044	.483**	1

** = correlation is significant at 0.01level, * = correlation is significant at 0.05 levels

Table 8: Regression analysis of growth variables of *Ceiba pentandra* on seedlings height

	Undstandardized Coefficients		Standardized coefficients				
Model	B	Std. error	Beta	t	Sig.	R^2	SEE
Constant	0.076	1.128	0.067	0.946	0.000		
Ger.media	-1.503	0.285	-0.102	0.264	0.000**		
Week	0.911	0.100	0.248	9.154	0.000**		
Treatment	-0.430	0.229	0.029	-1.880	0.061^{ns}		
Collar girth	0.645	0.114	0.098	5.665	0.000**		
Leaf area	0.574	0.060	0.206	9.497	0.000**		
Number of leaf	0.384	0.021	0.592	17.969	0.000**	0.875	4.26

Dependent variable = plant height, ** = highly significant at 1% probability level,
* = significant at P< 0.05 and ^{ns} = Not significant.

Discussions

The 5hrs sun-dried for 5days and 24 hours seed soaked in water shows superior germination compared with the control. The highest germination recorded in 5hrs sun-dried for 5days seed sown could be attributed to the fact that temperature has been observed to strongly influence seed germination. This is in agreement with (Pearson *et al.*, 2002). Moisture and temperature are necessary requirement for seed germination.

Since the seed soaked in water for 24hours absorbed moisture, this could have contributed to its rapid rate of germination. Also, the necessary temperature required by the seed to germinate had been supplied by 5hrs sun-dried for 5days; this could have contributed to its rapid rate of germination. Although, there was no significant difference in the rate of germination among the seed pretreatments meaning that without pretreatment, the seed of *Ceiba pentandra* will germinate fairly well. This observation is in line with (Apetorgbor *el, al.,* 2003).

The correlation analysis showed that, there was a positive significant relationship between seedling height and number, also a positive significant correlation between plant height and collar girth means that as the height increases, it is expected that the numbers of leaf of the seedlings also increase, this also indicates that plant height depend largely on collar girth. While the result of regression analysis on the effects of growth variables on seedlings height had coefficient of determination (R^2 = 87.5); meaning that, the assessed growth variables had about 87.5% effects on the seedlings height of *Ceiba pentandra*. This result is in line with (Apertorgbor *et al.,* 2003). The result of regression shows that there was a significant difference in the growth of the seedlings due to germination media, collar girth, leaf area and number of leaves but shown no significant difference in the height due to seed pretreatment.

Conclusion

The result revealed that the 5hrs sun-dried seeds for 5days and the seeds soaked for 24 hours in water improved seed germination better than seed sowed without pretreatment. It also showed that top soil better supported early growth of *Ceiba pentandra* seedlings than river sand and sawdust. The result of the correlation analysis showed that, there was a significant correlation between seedlings height and number of leaf, the same trend was recorded that there was a significant correlation between seedlings height and collar girth.

Recommendations

From the result of this study, it is recommended that the 5 hours sun-dried seeds for 5 days pre-treatment and the seed soaked in water for 24 hours performed better than the control and therefore should be adopted in raising *Ceiba pentandra* seedlings in the nursery.

It is also recommended that top soil should be adopted in raising *Ceiba pentandra* seedlings in the nursery, since seedlings on top soil performed better than seedlings on both river sand and sawdust. However, further research on the appropriate seed pretreatment method and germination media most suitable for germination and growth of *Ceiba pentandra* should be carried out. This will go a long way to increase the production of *Ceiba pentandra* trees and guarantee its sustainable supply to the forest industries.

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