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ASSESSMENT OF GROWTH RESPONSE OF *Canariumschweinfurthii*EnglSEEDLINGS TO DIFFERENT SEED SOURCES AND PRE-SOWING TREATMENTS

[1]Anozie, E.Land [2]Oboho, E.G.

[1]Department of Forestry and Environmental conservation, Clemson University, South Carolina,USA.
[2]Department of Forest Resources and Wildlife Management, University of Benin, Edo state, Nigeria.
***Correspondence Author:** eberelorettto@gmail.com;+2348066448766

ABSTRACTS

The effect of seed source and different pre-sowing treatment on early growth response of Canariumschweinfurthii seedlings were investigated using seeds from two different sources namely; Unubi (T_1) and Jos (T_2). The experiment was laid out in a completely randomized design (CRD) pattern using 2x7 factorial combination of 2 sources and 7 pre-sowing treatments. Data collected were subjected to Analysis of variance (ANOVA) using SAS software package version 9.0. Significant means were separated with LSD (least significant Difference) tested at 5% level of probability. The pre-sowing treatments were complete removal of seed coat (CR), partial cracking (PC), burning under dry grass (BG), 70% H_2S0_4 (7H), 80% H_2S0_4 (8H) ,3 days (72 hours) soaking in water (SW) and control (CT). Growth response was determined by measuring the seedling height, collar girth, chlorophyll concentration index (CCI), crude leaf area (CLA), number of leaves, root and shoot length, root and shoot dry and fresh weights. Treatment SW generally had the best growth performance in seedlings height, collar girth, CCI, CLA, number of simple and compound leaves, SL, SFW, SDW, RL, RFW and RDW with 78.77cm ,4.68cm, 25.57mm, 168.57cm^2, 7,8, 78.77cm, 131.68g, 48.38g,35.42cm,41.08g and 16.02g respectively. While the poorest growth was recorded in seedlings treated with H_2S0_4 (7H,8H). There was no significant difference in growth of the seedlings in the investigated sources. But there was significant difference in the seedling growth responses with respect to pre-sowing treatment. Therefore, to obtain optimum growth response of Canariumschweinfurthii, treatment SW is recommended. Any pre-sowing treatment that will drastically alter the seed coat is detrimental to the growth of Canarium schweinfurthii seedlings as observed in treatments CR, PC, 7H and 8H. Also, the seeds of Canarium schweinfurthii to be used for any planting and seedling growth purposes can be sourced from any location.

Key words: *Canarium schweinfurthii*, seed sources, seedlings, early growth, pre-sowing treatments

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INTRODUCTION

Forest have been known to provide man with numerous benefits ranging from timber to non-timber forest products (Obohoet *al*., 2020). So many people depend on forest and its products as a means of livelihood enhancer (Anozie *et al*., 2022). The rapid loss of forest and its resources through factors such as deforestation and urbanization are quite alarming, and the rate at which tree species are being felled for timber, forage, fruits, commercial and other purposes is very high whereas the regeneration and afforestation of the species is virtually nothing to write home about, as there is an annual decline in the rate of plantation establishment (Rotowa*et al*., 2020). Also, the inability of some forest seeds to germinate when the necessary conditions for germination are made available pose a serious threat to the existence of our forests (Anozie *et al*.,2020). *Canarium schweinfurthii*Engl (African elemi) belongs to the Burceraceae family whose geographical distribution are widely spread throughout Africa (Anozie and Oboho 2019 and Tchouamo *et al.,* 2000). It is called 'Atili'in Hausa,"Origbo or Elemi' in Yoruba Ube mgba' or' Ube okpoko'inIgbo, (Orwa*et al*., 2009) and in English, it is called Torchwood, frankincense, Black olive, forest pear or Bush candle tree (Nyam *et al*,2014).

Canarium schweinfurthii is a large forest tree with the crown reaching to the upper forest canopy, with a long clean, straight, cylindrical bole exceeding 50 m Orwa *et al*(2009). The diameter above the heavy root swelling can be up to 4.5 m. The bark is thick, on young tree, it is fairly smooth, becoming increasingly scaly and also fissured with age, (Dawang *et al*, 2016, Orwa *et al*2009). Branching begins at 7 m or more, giving the tree the appearance of a flagpole. The fruit is a small drupe, which appears greenish when unripe and bluish-purple when ripe, glabrous, 3-4 cm long and 1-2 cm thickOrwa *et al*(2009). The fruits are of two varieties namely; long spiral and short round (Maduelosi and Angaye, 2015). The fruit contains a hard spindle-shaped, trigonous stone seed coat that eventually splits releasing seeds, mainly 2 or 3seedsOrwa*et al*(2009).

The fruit can be eaten raw or soften in warm water to improve palatability (Dawang*et al*, 2016) and eaten like that of *Dacryodes edulis* (local pea). The tree grows wild in forests and common land. Local people gather the fruits which have a ready market, *Canarium schweinfurthii* therefore helped these people to supplement their income. Other benefits derived from *Canarium schweinfurthii* includes food, fuelwood, timber, gum and resins, medicinal uses(Nyam*et al*,2014), the seeds are also used as a flooring material for decoration. Decline in the population of *Canarium schweinfurthii* and other valuable indigenous fruit trees in Nigeria is disturbing and has currently, become an ecological concern, (Nuga and Ofodile, 2010).The main causes for this massive deforestation in the country have been highlighted to include; the growing human population, urbanization, industrialization and consequent higher demand for agricultural products and fuelwood (Ndulue *et al*.,2020, Ekanade *et al.*, 1998).Other reasons includes illiteracy and ignorance of the people who believe that forests are free gifts of nature that cannot be exhausted, including the non-enforcement of forest laws and corruption (Oboho and Ngalum, 2014, Adekunle and Akinlemibola, 2008).These stated reasons are serious threats to forest conservation and utilization of different indigenous fruits trees such as C*anarium schweinfurthii.* Despite the economic importance of *Canarium schweinfurthii* in Nigeria, the existence of these species is being threatened by increased urbanization, deforestation and other infrastructural developments (Anozie and Oboho, 2019). A lot of seeds are lost annually due to low germination and poor early growth status after fruit fall from the mother tree (Egwunatum *et al*., 2020), the hard seed coat dormancy being partly responsible, therefore threatening the existence of this species. Therefore, there is need to test different pre-sowing treatments that may break the seed dormancy to ensure quick and optimum growth of this species. Early seedling growth and development plays a very crucial role in the life of any plant.

As seedling early growth has direct effect on the seedling development, survival in field and plant productivity (Anozie*et al*., 2020). Hence, the aim of this investigation was to evaluate the effect of seed sources and different pre-sowing treatments on early growth response of *Canarium schweinfurthii* seedlings.

MATERIALS AND METHODS

The experiment was carried out at the Department of Crop Science screen house, Faculty of Agriculture, University of Benin, Benin-City, Edo State, Nigeria .The GPS location of the screen house is Latitude 6^{o} 33^{1}N and Longitude 5^{o} 37^{1}E with an elevation of

152.4m above the sea level. Benin City is in the rainforest zone of Nigeria with a bimodal rainfall pattern, having an average mean rainfall of 2,300mm per annum and mean temperature of 25.1°C (Egharevba *et al.,* 2005).

Seed collection and preparation

The seeds used in this experiment were procured from two different geographical locations. Mature ripe fruits of *Canarium schweinfurthii* were gathered from a superior mother tree from Unubi (T_1) in Anambra State and Jos (T_2) in Plateau State. After the fruit's procurement, they were tied for five days in order for the fruits to ferment and soften for easy extraction of the seed. The extracted seeds were carefully prepared using different pre-sowing treatments and planted as recommended by Anozie and Oboho (2019).

Experimental design

Completely randomized design (CRD) was used in the study. There were 14 treatments made up from factorial combinations of 2 seed sources (Anambra and Jos) and 7 pre-sowing treatments which includes Control (CT), Complete seed coat removal (CR), Partial cracking ofseeds (PC), Soaking of seeds in cool water for 3 days (72 hours) (SW), Light burning of the seeds under dry grass (BG), Treatment of seeds with 70% sulphuric acid for 5mins (7H)' Treatment of seeds with 80% sulphuric acid for 5mins (8H).

Data collection techniques

Data was collected based on growth response assessment. The first three (3) seedlings to germinate per treatment was marked or labeled for use in growth assessment of the germinated seedlings. The effect of different pre-sowing treatments on growth of Canarium *schweinfurthii* seedlings was evaluated by measuring some growth variables at six weeks after germination. Growth variables measured on fortnightly basis included; Plant height, Collar girth, Number of leaves, crude leaf area (CLA), Chlorophyll concentration index (CCI).

At termination of study (18 weeks after germination), three seedlings from each treatment were used to determine fresh and dry weight by measuring the following: Shoot length(SL),Shoot fresh weight(SFW),Shoot dry weight(SDW),Root length(RL),Root fresh weight (RFW),Root dry weight (RDW).

Three seedlings from each treatment were uprooted and separated into shoots and roots. Fresh weights were measured with a scale and recorded. Dry weight was determined by oven drying samples to constant weight at 80°C for 48 hours before weighing. Weekly growth or increment was calculated by adding 6WAG value up to 18WAG value and divided it by 12 weeks.

Data analysis

Data collected were subjected to Analysis of variance (ANOVA) using SAS software package version 9.0 (SAS 2002). Means were separated with LSD (least significant Difference) test at 5% level of probability.

RESULTS

Early growth response characteristics

The result of early growth characteristics of *Canarium schweinfurthii* revealed that the crop has moderate growth rate in the nursery. The seedlings from T_2 source generally performed better than those of T_I source (Plates 1a, b). The results of the growth parameters investigated were observed to have followed a similar pattern as there was no significant difference between the two sources and their interactions but there was significant difference among the treatments in the investigated parameters as shown below:

The effects of seed sources and pre-sowing treatments on height of *Canrium schweinfurthii* seedlings

The results in Table 1 shows that at 18th weeks after germination (WAG) the mean height for the seed sources, T1 and T2 were 55.56cm and 62.06cm respectively. At 18th WAG, it was observed that treat Soaking in water had the highest seedling mean height, followed by burning under dry grass, control, complete removal of seed coat, partial cracking, 70% H_2S0_4 and 80% H_2S0_4 with 78.77cm, 77.27cm, 73.33cm, 50.98cm, 48.33cm, 46.73cm, and 0.00cm respectively irrespective of the source (Table 1). There was no significant difference between the height of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

Table 1: Height (cm) of *Canrium schweinfurthii* seedlings under various treatments and seed sources

Seed Sources (S)	Weeks After Germination							
	HPW	6	8	10	12	14	16	18
Unubi (T_1)	3.23	15.80	22.91	29.51	30.87	39.91	48.37	55.56
Jos (T_2)	3.65	18.27	23.70	29.61	34.88	48.94	56.40	62.06
LSD		6.794	7.691	8.401	11.332	12.079	14.978	18.704
Sig		Ns	ns	Ns	Ns	Ns	Ns	ns
Pre-sowing trt (P)								
Removal of seed coat (CR)	3.13	12.73^b	15.00^b	19.77^b	26.43^b	30.67^b	39.92^b	48.33^b
Partial cracking (PC)	3.09	13.80^b	19.87^{ab}	23.27^b	31.97^b	40.03^b	43.88^b	50.98^b
Burning under dry grass(BG)	4.80	19.65^a	25.73^a	34.48^a	42.27^a	48.63^a	57.45^a	77.20^a
80% H_2S0_4(8H)	0.00	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
70% H_2S0_4(7H)	2.78	13.33^b	19.97^{ab}	22.27^b	28.78^b	31.67^b	42.42^b	46.73^b
Soaking in water (SW)	5.08	17.87^a	22.67^a	30.57^a	42.27^a	53.77^a	68.73^a	78.77^a
Control (CT)	4.99	18.40^a	23.88^a	31.47^a	41.98^a	46.77^a	56.45^a	73.33^a
LSD		12.098	15.775	18.974	22.587	25.855	29.409	35.380
Sig		**	**	**	**	**	**	**
Interaction								
S X P		Ns	ns	Ns	Ns	Ns	Ns	ns

***Key**: Means within columns with different superscripts are significantly different*
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; HPW = Height growth per week.*

The effects of seed sources and pre-sowing treatments on the collar girths of *Canrium schweinfurthii* seedlings

The results in table 2 shows that at 18th weeks after germination (WAG) the mean collar girths for the seed sources, T1 and T2 were 2.63cm and 2.48cm respectively. At 18th WAG, it was observed that treat SW had the highest seedling mean collar girths, followed by control, burning under dry grass, complete removal of seed coat, partial cracking, 70% H_2S0_4 and 80% H2S04, with 4.68cm, 4.45cm, 4.10cm, 2.98cm, 2.73cm, 1.93cm, and 0.00cm respectively irrespective of the source (Table 2). There was no significant difference between the collar girths of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

The effects of seed sources and pre-sowing treatments on the chlorophyll concentration of *Canrium schweinfurthii* seedlings

The results in table 3 shows that at 18th weeks after germination (WAG) the mean height for the seed sources, T1 and T2 were 21.27mm and 22.58mm respectively. At 18th WAG, it was observed that control treatment had the highest seedling mean chlorophyll concentration index, followed by soaking in water, burning under dry grass, partial cracking, complete removal of seed coat, 70% H_2S0_4 and 80% H_2S0_4 with 26.33mm, 25.57mm, 25.25mm, 21.65mm, 20.01mm, 18.13mm, and 0.00mm respectively irrespective of the source (Table 3). There was no significant difference between the chlorophyll concentration indexes of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

Table 2: Collar girths (cm) under various treatments and seed sources.

Seed Sources (S)	Weeks After Germination							
	WGI	6	8	10	12	14	16	18
Unubi(T_1)	0.12	1.14	1.38	1.68	2.04	2.39	2.55	2.63
Jos(T_2)	0.12	1.00	1.30	1.67	2.05	2.29	2.41	2.48
LSD		0.407	0.539	0.689	0.843	1.007	1.044	1.133
Sig		Ns	ns	Ns	Ns	Ns	Ns	ns
Pre-sowing trt (P)								
Removal of seed coat (CR)	0.21	0.47^b	0.88^b	1.07^b	1.80^b	1.98^b	2.17^b	2.98^b
Partial cracking (PC)	0.17	0.65^b	0.85^b	1.15^b	1.47^b	1.67^b	1.96^b	2.73^b
Burning under dry grass (BG)	0.19	1.77^a	2.37^a	3.00^a	3.53^a	3.78^a	4.05^a	4.10^a
80% H_2S0_4 (8H)	0.00	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
70% H_2S0_4 (7H)	0.10	0.78^b	0.88^b	1.10^b	1.33^b	1.57^b	1.72^b	1.93^b
Soaking in water (SW)	0.23	1.97^a	2.57^a	3.18^a	3.73^a	4.37^a	4.67^a	4.68^a
Control (CT)	0.22	1.80^a	2.27^a	2.85^a	3.57^a	3.88^a	4.25^a	4.45^a
LSD		0.762	1.008	1.291	1.576	1.884	1.952	2.120
Sig		**	**	**	**	**	**	**
Interaction								
S X P		Ns	ns	Ns	Ns	Ns	Ns	ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; WGI= weekly girth increment.*

Table 3: Chlorophyll concentration index (mm) for sources and different treatments

Seed Sources (S)	Weeks After Germination							
	WCC	6	8	10	12	14	16	18
Unubi (T_1)	0.30	17.70	18.50	18.65	19.02	19.15	19.31	21.27
Jos(T_2)	0.37	18.15	19.06	19.78	20.21	20.30	20.72	22.58
LSD		5.283	5.426	5.640	5.638	5.834	6.168	6.441
Sig		Ns	Ns	Ns	ns	Ns	ns	Ns
Pre- sowing trt (P)								
Removal of seed coat (CR)	0.44	15.10^b	15.27^b	16.33^b	16.48^b	17.63^b	19.97^b	20.01^{ab}
Partial cracking (PC)	0.39	16.28^b	16.60^b	17.00^b	17.78^b	18.07^b	19.85^b	21.65^{ab}
Burning under dry grass (BG)	0.56	18.56^a	22.55^a	23.17^a	23.78^a	23.75^a	25.22^a	25.25^a
80% H_2S0_4 (8H)	0.00	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
70% H_2S0_4 (7H)	0.32	14.03^b	14.18^b	14.25^b	15.48^b	15.87^b	16.08^b	18.13^b
Soaking in water (SW)	0.41	20.65^a	24.82^a	24.13^a	24.82^a	24.70^a	25.40^a	25.57^a
Control (CT)	0.84	19.25^a	23.02^a	26.08^a	26.10^a	26.03^a	25.89^a	26.33^a
LSD		8.603	9.279	9.681	9.677	10.044	11.669	12.179
Sig		Ns	**	**	**	**	**	**
Interaction								
S X P		Ns	Ns	Ns	ns	ns	ns	Ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; WCCI= Weekly chlorophyll concentration index.*

The effects of seed sources and pre-sowing treatments on the crude leaf area of *Canrium schweinfurthii* seedlings

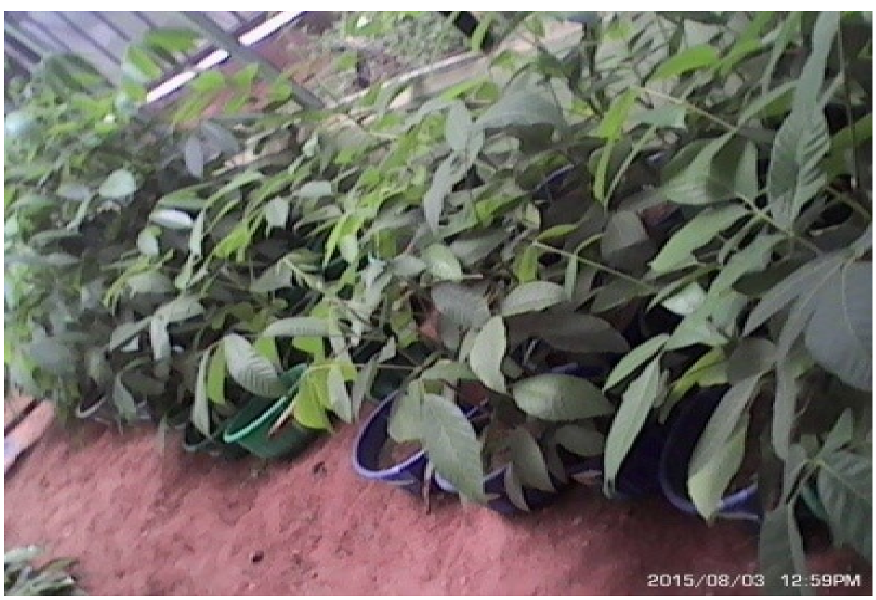
The results in Table 4 shows that at 18th weeks after germination (WAG) the mean crude leaf area for the seed sources, T1 and T2 were 109.44cm^2 and 110.63cm^2 respectively. At 18th

WAG, it was observed that soaking in water treatment had the highest seedling mean crude leaf area, followed bycontrol, burning under dry grass, complete removal of seed coat,70% H_2S0_4, complete removal of seed coat, and 80% H_2S0_4 with 168.57cm^2, 157.33 cm^2, 150.49 cm^2, 110.29 cm^2, 108.17 cm^2,104.89 cm^2 and 0.00 cm^2 respectively irrespective of the source (Table 4). There was no significant difference between the crude leaf area of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

Table 4: Crude Leaf Area (CLA) (cm^2) of seed sources and different treatments.

Seed Sources (S)	Weeks After Germination							
	WCLA	6	8	10	12	14	16	18
Unubi (T_1)	3.32	69.61	70.60	82.63	84.27	86.19	91.24	109.44
Jos(T_2)	4.01	62.53	80.22	85.36	81.38	84.81	98.42	110.63
LSD		26.669	26.994	27.247	28.094	28.895	32.480	38.726
Sig		Ns	Ns	Ns	Ns	Ns	Ns	Ns
Pre-sowing trt(P)								
Removal of seed coat (CR)	4.34	52.80^b	71.00^b	81.49^b	88.82^b	93.92^b	98.39^b	104.89^b
Partial cracking (PC)	4.04	61.83^b	70.00^b	74.27^b	86.00^b	95.12^b	104.23^b	110.29^b
Burning under dry grass (BG)		125.41^a	136.00^a	149.47^a	152.19^a	151.56^a	156.91^a	150.49^a
80% H_2S0_4 (8H)	0.00	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
70% H_2S0_4 (7H)	3.99	64.32^b	80.70^b	88.74^b	92.68^b	98.27^b	101.51^b	108.17^b
Soaking in water (SW)	3.94	121.27^a	134.50^a	154.56^a	155.45^a	162.98^a	164.77^a	168.57^a
Control (CT)	3.46	115.86^a	111.20^{ab}	149.47^a	151.64^a	158.68^a	159.49^a	157.33^a
LSD		49.893	50.649	50.975	52.558	54.057	60.765	55.613
Sig		Ns	**	**	**	**	**	**
Interaction								
S X P		Ns	Ns	Ns	Ns	Ns	Ns	Ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; WCLA = weekly crude leaf area*



1a: Investigated seedlings of T_1 at 18 WAG; Plate 1b: Investigated seedlings of T_2 at 18 WAG

Number of Leaves

In the early growth stage, *Canarium schweinfurthii* exhibited two leaf types. From the first week of emergence up to the 6 weeks after emergence, there were simple leaves (Plate 2a) and from the 7weeks the compound leaves began to emerge above the persistent simple leaves below (Plate 2b).

Plate 2a: Simple leaves of *Canarium sweinfurthii* seedlings at 6 WAG

Plate 2b:Compound leaves of *Canarium Sweinfurthii* seedlings at 14WAG

The effects of seed sources and pre-sowing treatments on number of simple leaves of *Canrium schweinfurthii* seedlings

The results in table 5 shows that at 18th weeks after germination (WAG) the mean number of simple leaves for the seed sources, T1 and T2 were 5.49 and 4.95 respectively. At 18th WAG, it was observed that control treatment had the highest seedling mean number of simple leaves, followed by burning under dry grass, soaking in water, partial cracking, complete removal of seed coat, 70% H_2S0_4, and 80% H_2S0_4 with 7.67,7.40,7.00,4.17,4.0,4.0 and 0.00 respectively irrespective of the source (Table 5). There was no significant difference between the numbers of simple leaves of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

Table 5: Number of Simple Leaves of seedlings from sources T_1 and T_2 under various treatments

Seed Sources (S)	Weeks After Germination							
	SPW	6	8	10	12	14	16	18
Unubi(T_1)	0.13	4.00	4.95	5.14	5.28	5.49	5.49	5.49
Jos(T_2)	0.17	3.87	4.74	4.57	4.95	4.95	4.95	4.95
LSD		1.291	1.563	1.664	1.4750	1.946	1.946	1.946
Sig		Ns	Ns	Ns	ns	Ns	Ns	Ns
Pre-sowing trt(P)								
Removal of seed coat (CR)	0.01	3.83^b	3.60^b	3.86^b	4.00^b	4.00^b	4.00^b	4.00^b
Partial cracking (PC)	0.04	3.67^b	3.77^b	3.93^b	4.17^b	4.17^b	4.17^b	4.17^b
Burning under dry grass (BG)	0.2	5.00^a	6.50^a	7.33^a	7.40^a	7.40^a	7.40^a	7.40^a
80% H_2S0_4 (8H)	0.00	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
70% H_2S0_4 (7H)	0.11	3.67^b	3.83^a	3.43^a	3.67^b	4.00^b	4.00^b	4.00^b
Soaking in water (SW)	0.15	5.17^a	6.67^a	7.00^a	7.00^a	7.00^a	7.00^a	7.00^a
Control (CT)	0.21	5.17^a	7.00^a	7.17^a	7.67^a	7.67^a	7.67^a	7.67^a
LSD		2.042	2.550	2.553	2.912	3.189	3.189	3.189
Sig		Ns	**	**	**	**	**	**
Interaction								
S X P		Ns	ns	Ns	ns	Ns	Ns	Ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; SPW = Simple leaves per week.*

The effects of seed sources and pre-sowing treatments on number of compound leaves of *Canrium schweinfurthii* seedlings

The results in table 6 shows that at 18th weeks after germination (WAG) the mean number of compound leaves for the seed sources, T1 and T2 were 6.00 and 6.33 respectively. At 18th WAG, it was observed that control treatment had the highest seedling mean number of compound leaves, followed by soaking in water, burning under dry grass, partial cracking, complete removal of seed coat, 70% H_2S0_4, and 80% H_2S0_4 with 8.50,8.00,7.33,5.83,5.67,4.89 and 0.00 respectively irrespective of the source (Table 6). There was no significant difference between the numbers of compound leaves of seedlings in the investigated sources but there was significant difference between the pre-sowing treatments.

Table 6: Compound Leaves of seedlings from sources Unubiand Jos under different treatments

Seed Sources	Weeks After Germination							
	CPW	**6**	**8**	**10**	**12**	**14**	**16**	**18**
Unubi(T_1)	0.50	0.00	0.14	0.57	1.67	2.67	4.33	6.00
Jos (T_2)	0.53	0.00	0.10	0.67	1.54	2.95	5.19	6.33
LSD		0.000	0.210	0.537	0.942	1.575	1.987	2.531
Sig		-	Ns	ns	ns	Ns	Ns	Ns
Pre-sowing trt (P)								
Removal of seed coat (CR)	0.47	0.00^a	0.17^a	0.50^{ab}	1.8^b	2.03^c	3.50^b	5.67^b
Partial cracking (PC)	0.49	0.00^a	0.17^a	0.67^{ab}	1.33^b	2.09^c	4.33^b	5.83^b
Burning under dry grass (BG)	0.61	0.00^a	0.00^b	0.50^{ab}	1.67^b	4.00^b	5.83^a	7.33^a
80% H_2S0_4 (8H)	0.00	0.00^a	0.00^b	0.00^c	0.00^c	0.00^d	0.00^c	0.00^c
70% H_2S0_4 (7H)	0.41	0.00^a	0.00^b	1.33^a	2.33^{ab}	3.33^b	4.83^b	4.89^b
Soaking in water (SW)	0.67	0.00^a	0.33^a	1.33^a	3.00^a	5.33^a	7.00^a	8.00^a
Control (CT)	0.71	0.00^a	0.17^a	1.00^{ab}	3.00^a	4.67^a	6.83^a	8.50^a
LSD		0.000	0.393	1.004	1.761	2.947	3.529	4.200
Sig		-	Ns	ns	**	**	**	**
Interactions								
S X P		ns	Ns	ns	ns	Ns	Ns	Ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at P< 0.05; Ns = not significantly different at P< 0.05; CPW = compound leaf per week.*

Growth Response at Harvest (18WAG) of seedlings from T_1 and T_1 sources and under different treatments

The results in table 7 shows that at 18th weeks after germination, at the termination of the experiment, the mean shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, root dry weight for the seed sources, Unubi and Jos were 55.56 cm, 74.28g, 32.06 g, 26.13 cm, 27.37 g, 12.43g for Unubi and 62.06 cm, 78.65 g, 36.89 g, 28.56 cm, 30.32 g, 13.69 g for Jos respectively.

At 18th WAG, it was observed that soaking in water treatment had the overall best performance in shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, root dry weight 78.77 cm, 131.68 g, 48.38 g, 35.42 cm, 42.22g and 17.89 g respectively, irrespective of the source (Table 7). There was no significant difference between the shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, root dry weight of seedlings in the investigated sources but there was significant difference between the shoot length, shoot fresh weight, shoot dry weight, root length, root fresh weight, root dry weight of pre-sowing treatments.

Table 7: Growth Response at Harvest (18WAG) of seedlings from T_1 and T_1 sources and under different treatments

Seed Sources (s)	Shoot length (SL) (cm)	Shoot Fresh Weight (SFW) (g)	Shoot Dry Weight (SDW) (g)	Root Length (RL) (cm)	Root Fresh Weight (RFW) (g)	Root Dry Weight (RDW) (g)
Unubi (T_1)	55.56	74.28	32.06	26.13	27.37	12.43
Jos (T_2)	62.06	78.65	36.89	28.56	30.32	13.69
LSD	18.704	21.106	11.054	9.498	10.126	8.115
Sig	Ns	Ns	Ns	ns	Ns	Ns
Pre-sowing trt (P)						
CR	48.33^b	70.46^b	30.37^b	21.05^b	30.63^{ab}	12.46^b
PC	50.98^b	90.69^b	33.88^b	24.50^b	22.56^b	10.35^b
BG	77.20^a	128.76^a	45.98^a	32.43^a	32.68^{ab}	15.84^a
8H	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c	0.00^c
7H	46.73^b	78.65^b	29.47^b	24.89^b	21.98^b	9.83^b
SW	78.77^a	131.68^a	48.38^a	35.42^a	42.22^a	17.89^a
CT	73.33^a	130.20^a	47.01^a	34.42^a	41.08^a	16.02^a
LSD	35.380	40.896	21.641	18.286	20.980	17.978
Sig	**	**	**	**	**	**
Interactions						
S X P	Ns	Ns	Ns	ns	Ns	Ns

Key: Means within columns with different superscripts are significantly different
***= significantly different at $P< 0.05$; Ns = not significantly different at $P< 0.05$*

DISCUSSION

*Canariumschweinfurthii*seedlings had moderate growth rate. There were no significant differences in the growth response of seedlings from the two sources, Although seedlings from Jos was observed to have numerical values that was slightly higher than seedlings from Unubi for plant height, chlorophyll concentration index, crude leaf area, compound leaves, shoot and root lengths, fresh and dry weights, leaf fresh and dry weights all of which were not statistically significant. Tinsea *et al.,* (2014) observed that there was no significant difference in the shoot and root length, fresh and dry weights of the seedlings of *Tamarindus indica* obtained from three different sources.

The pre-sowing treatments irrespective of the seed source had direct effects on the seedling's growth response, as treatments soaking in water generally had better growth response in all the growth parameters measured than other treatments. This increase in growth response observed in soaking in water treatment supports the findings of Joybi and Uma (2017) who also recorded increase in seedlings height, number of leaves, collar girth and root length in *Annona muricata* seedlings. Also, the increase in growth response of SW concurred with the findings of Hossain *et al.,* (2005), who stated that treatment with soaking in water increased the plant height, collar girths, number of leaves, root and shoot lengths of seedlings.

This reportcontradicts the findings of Ehiagbanare and Onyibe (2007) who recorded poor seedling growth in *Tetracarpidium conophorun* seedlings treated by with soaking in water. Treatment BG also recorded increase in seedlings height, which was an indication that the heat shock from fire might have activated the nutrient composition and stored food which was made available for seedlings absorption that led to increase in plant height, number of seedlings, collar girths and increase in other growth parameters measured. This concurs with the findings of Keeley and Fotheringham (2000) who added that heat from fire accelerates the mineralization of organic matter, making organic nutrients more readily available for seed germination and seedling growth. Also, the increase in growth rate of BG supported the findings of Cocks and Stocks, (1997) that increase in temperature through burning do not only increases germination percentages but also increases the seedling growth responses.

The findings of this study showed that treatments soaking in water, burning under dry grass and control had higher increase in number of leaves and crude leaf area, and this increase might have contributed to a higher photosynthesis (an increase in CCI) thereby, making more food and nutrients available for seedling absorption, which could have in turn resulted to a higher plant growth and biomass production (Shiferaw *et al*.,2010) as observed in these three treatments . However, their longer tap roots might also increase the surface area for nutrient uptake from the soil and this could lead to an increase in seedling height (shoot length) and also important for a higher and a better growth performance. The increase in number of leaves, CCI, CLA, root and shoot length with fresh and dry weights of treatments BG, SW and CT seedlings supports the findings of Shiferaw *et al*., (2010) who stated that, the seedlings longer tap root length and higher number of secondary roots might increase the surface area for efficient absorption of water and nutrients from the soil and provides physical support of the plant , while higher shoot and root length values also important for higher growth performance with better adaptation capacity of the seedlings at field conditions.

Generally, treatments BG, SW and CT had better growth response (higher plant height, collar girth, CCI, CLA, simple and compound leaves, root and shoot lengths, fresh and dry weights) than other treatments which implies pre-sowing treatments had effect on seedling growth. It was observed during the seedling germination stage by the researcher, as reported by Anozie and Oboho (2019), that treatments BG, SW and CT had higher germination percentages than treatments CR,PC,7H and 8H. This observation concurs with the findings of Vijendrkumar *et al*., (2014) who reported that pre-sowing treatments had positive effect on the seedling growth of *Ruta graveolens* as those treatments with higher germination percentages also had higher growth responses.This is also in agreement with Haider *et al.,* (2016) who reported that good pre-sowing treatments that resulted in higher germination percentages will also affect the seedling growth positively.

Tinsae *et al.,* (2014) also reported that, there were statistical differences in the growth of *Tamarindus indica* seedlings from different pre-sowing treatments irrespective of their sources. Treatments BG, SW and CT whose seed coats were not mechanically or chemically altered had a better growth response over treatments CR, PC ,7H and 8H whose seed coats were mechanically and chemically altered (completely removed, partially cracked and chemically burned respectively). This poor growth response observed in treatments CR, PC, 7H, 8H supports the reports of Ehiagbanare and Onyibe (2007) who also recorded poor growth with treatment with mechanical scarification and zero germination with no growth in treatment with H_2S0_4 in *Tetracarpidium conophorum* seeds. These could probably mean that the seed coat plays an important protective role in seedling early growth as noted byOboho (2015) who stated that for these type of species which had epigeal germination and foliaceous seedlings, the seed coat (testa) plays a very crucial protective role during the germination, early growth and survival of the seedlings.

CONCLUSION

This study revealed that *Canarium schweinfurthii* seedlings had moderate growth rate. The best treatment to enhance growth rate of *Canarium schweinfurthii* seedlings was treatment SW. This investigation revealed that any pre-sowing treatment that will drastically altered the seed coat mechanically and chemically is detrimental to the growth of *Canarium schweinfurthii* seedlings as observed in treatments CR, PC, 7H and 8H.Therefore seed coat (testa) plays a very crucial protective role during the early growth and survival of the seedlings of this crop. Its seedlings had moderate growing potentials and there is no significant difference in the growth response of the seedling from the sources but pre-sowing treatments showed significant differences. The seeds of *Canarium schweinfurthii* to be used for planting purposes could be sourced from any location, as there was no significant difference in the growth response between the seedlings (T_1 and T_2) sources used in this study.

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