



## Provenance trial of *Gmelina arborea* (Roxb.) in middle-Belt Zone of Nigeria

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### Abstract

A field experiment was conducted to examine the provenance germination and growth trial of *Gmelina arborea* (Roxb.) within three states (Makurdi, Nasarawa and Abuja) in middle-belt zone of Nigeria. The experiment was carried out in the nursery site of the Department of Forestry and Wildlife Management, Nasarawa State University Lafia. 500 seeds of *Gmelina* were collected from each location, it was sun-dried for 6 hours and then soaked in water for 24 hours to break its dormancy and improve its germination rate. It was then planted on germination beds in the nursery and transplanted after two weeks of germination into nursery pots and data was recorded on Plant height, Number of leaves and collar girth. The study was laid in a Randomized Completely Block Design (RCBD), Analysis of variance was performed on the data to show the comparative performance of each treatment with another. Duncan's Multiple Range Test (DMRT) was applied to locate where the significant difference occur among the seeds. The result of germination with respect to location revealed that *G. arborea* seed collected from Nasarawa recorded the highest germination of plant height ( $34.75 \pm 9.24$ ) followed by seeds from Makurdi ( $33.66 \pm 6.54$ ) while the least ( $33.22 \pm 5.71$ ) was recorded on seeds collected from Abuja. Makurdi seeds recorded highest number of leaves ( $19.56 \pm 3.59$ ), followed by Nasarawa ( $18.68 \pm 3.39$ ) and the least ( $16.53 \pm 2.98$ ) in Abuja. The result of collar girth reveals that seeds collected in Lafia had the highest mean value ( $2.39 \pm 1.83$ ) followed by Abuja seeds ( $2.37 \pm 0.42$ ) and the least mean ( $2.01 \pm 0.34$ ) was recorded in Makurdi collections. The result of the correlation analysis revealed that there was a significant correlation between the plant height and other assessed parameters. The result of the regression analysis on the effects of growth variables on tree plant height had coefficient of ( $R^2 = 0.93$ ). Result of this study showed that location significantly affect germination and growth rate of *G. arborea*. Moreso, when raising *G. arborea* seedlings for plantation establishment in middle belt Nigeria, seeds sourced from Lafia should be considered and further research should be carried out on pretreatment of *G. arborea* seed.

**Keywords:** *Gmelina arborea*, seedlings, germination, seeds and plantation.

### Introduction

*Gmelina arborea* (Roxb.) is a pioneer tree native to Asia, it was introduced to tropical Africa from South-East Asia<sup>1</sup>. It was introduced to Enugu state, Nigeria in 1921 where an international provenance trial was established for *Gmelina arborea* and *Gmelina leichardtii* (F. Muell.) Benth. in Enugu. The trials were assessed on the provenance during the civil war when some of the trees were harvested for war purpose. The result of the provenance trials show that *Gmelina leichardtii* was not suited to Nigeria conditions. *Gmelina arborea*, on the other hand, showed high adaptability and vigour. Plantations of *Gmelina arborea* has since then being spreading to other parts of the country. Presently, plantations of *Gmelina arborea* are established mainly for timber, poles, pulp and paper production in many parts of the country<sup>2</sup>.

*Gmelina arborea* is a deciduous tree of verbenaceae family of and subclass of Dicotyledonea. The name *Gmelina* was given after eighteenth century by a German Botanist J.C Gmelina<sup>3</sup>. Other member of the family is *Tectona grandis* (L.F). Other species of *Gmelina* are *Gmelina dalrympleana* (F.Mull.) H.J

Lam., *Gmelina fasciculiflora* (Benth.), *Gmelina moluccana* (Blume.) Becker ex K.Heyne<sup>4</sup>. *Gmelina* consists of about 33 species of trees and shrubs. Its' trade name include *Gmelina*, *Gumhara* and *Gumhari*. It's a tree that reaches a height of about 35m and a diameter of more than 3m in the natural stands of the tropical and subtropical regions of Asia, it lives up to 40 years<sup>5</sup>. *Gmelina arborea* is a native of Pakistan, East of Myanmar and South of Srilanka, South China and Thailand. It is widely planted in these countries and large scale plantations are also found in Nigeria, Senegal, and Ghana<sup>6</sup>. *Gmelina arborea* grows best within the temperature range of 18°C and 35°C<sup>7</sup>. It grows well in areas with distinct dry season and annual rainfall range of 1,776mm and 2,280mm, atmospheric humidity of 40%<sup>7</sup>.

Due to the potentials of *Gmelina aborae* and an ever increasing demand for commercial and other purposes, *Gmelina aborae* plantations suffer massive deforestation without any reforestation or afforestation plan for the specie. Also, Beet reported that *Gmelina* is faced with the problem of annual bush burning, seed dormancy, poor seed viability, and over exploitation<sup>8</sup>. Hence, there is need to evaluate the growth rate of *Gmelina aborea* seeds collected from different locations within

middle belt Nigeria and mass raised in the nursery as an attempt and continuous attention to solve these problems.

## Materials and methods

**Study area and site preparation:** This experiment was carried out in the Departmental nursery of Forestry and Wildlife Department of the Faculty of Agriculture, Nasarawa State University Keffi, Shabu-Lafia Campus. Lafia, (08°35' N, 08°33' E), located in the Guinea Savannah zone of North Central Nigeria at an altitude of about 177m above sea level. The mean monthly maximum temperature range is between 35.06°C to 36.40°C and 20.16°C to 20.50°C respectively while the mean monthly relative humidity and rainfall are 74.67% and 168.90mm respectively<sup>9</sup>. A portion of land allocated was cleared with cutlass and hoe, the debris was packed and biological fencing was erected round the portion of land, then ground leveled.

**Seed collection, processing and Pretreatment:** The *Gmelina arborea* seeds were collected from Nasarawa State Polytechnic Lafia, University of Agriculture Makurdi and Agbekoya Farmers Association Kwali Abuja. The seeds were picked directly from the ground under plus trees of *Gmelina arborea*. The seeds were broadcasted in the nursery and out of which 500 young seedlings were later transplanted into polythene pots making a total of 1,500 seedlings used for this practical exercise.

**Treatment, seed sowing and silvicultural operation:** The seeds were sun-dried for 6 hours and then soaked in water for twenty-four hours in order to break its dormancy and improve its germination rate, after which it was sown on the nursery beds. The seeds were sown on the nursery bed and watered twice daily (mornings and evenings). From all the germinations, 500 seeds were sown in the pot from each location. The seedlings after two weeks of germination were transplanted into nursery pots at 4cm depth after which watering was done once daily (evenings). Hoeing and hand weeding were carried out in the nursery site so as to reduce competition between weeds and *Gmelina* seedlings for water, sunlight and nutrients.

**Parameter assessed and Data Analysis:** The parameter assessed for the period of 16 weeks are: Plant height, Collar girth and Leaf count. The Data collected was subjected to mean and Analysis of variance (ANOVA) and significant mean differences were separated at 0.05 probability level<sup>10</sup>. Correlation analysis was used to establish the relationship between the growths parameters of three (3) different seed sources.

## Results and discussion

**Mean result for growth variables on the basis of location and duration:** The result of the mean values of growth parameters assessed based on the location and duration is shown in Table-1. The seeds of *Gmelina* collected from Nasarawa had

the highest mean values of the growth parameters with 34.75±9.24 in plant height, followed by 33.66±6.54 in Makurdi and the least value of plant height was recorded in seeds collected from Abuja with mean value of 33.22±5.71. The result of number of leaves produced reveals that Makurdi seedlings had the highest number of leaf production with 19.56±3.59 followed by 18.68±3.39 recorded in Lafia seedlings while the least mean value of 16.53±2.98 was again recorded in Abuja seedlings. The result of number of collar girth reveals that *Gmelina arborea* seedlings sourced from Lafia again had the highest mean collar girth of 2.39±1.83, followed by 2.37±0.42 recorded in Abuja collections while the least mean collar girth of 2.01±0.34 was recorded in Makurdi collections. With respect to duration, the result showed that as the week increase the values of accessed parameters also increase. Week 16 recorded the highest mean growth parameter in all respect with 42.38±6.37cm in plant height, 22.76±3.95 number of leaves and 3.05±0.36cm in collar girth. Followed by week 12 with 39.38±6.37cm in Plant height, 20.76±3.05 number of leaves and 2.58±0.27cm on collar girth while week 4 had the least mean plant height (27.66±4.62), number of leaves (15.58±2.86) and collar girth with mean value of 1.99±1.82 (Table-1).

**Table-1:** Mean value and Duncan mean separation value for growth variables on the.

Source of variation	Plant height (cm)	Leave number	Collar girth (cm)
Location			
Nasarawa	34.75±9.24 <sup>a</sup>	18.68±3.39 <sup>a</sup>	2.39±1.83 <sup>a</sup>
Makurdi	33.66±6.54 <sup>a</sup>	19.56±3.59 <sup>b</sup>	2.01±0.34 <sup>b</sup>
Abuja	33.22±5.71 <sup>a</sup>	16.53±2.98 <sup>c</sup>	2.37±0.42 <sup>b</sup>
Duration			
4 weeks	27.66±4.62 <sup>a</sup>	15.58±2.86 <sup>a</sup>	1.99±1.82 <sup>a</sup>
8 weeks	34.59±5.46 <sup>b</sup>	18.43±2.66 <sup>b</sup>	2.18±0.37 <sup>a</sup>
12 weeks	39.38±6.37 <sup>c</sup>	20.76±3.05 <sup>c</sup>	2.58±0.27 <sup>b</sup>
16 weeks	42.38±6.37 <sup>c</sup>	22.76±3.95 <sup>c</sup>	3.05±0.36 <sup>b</sup>
General mean	38.87±7.32	19.26±3.55	2.85±1.11

Note: figures with the same alphabet in the same column are not significantly different, at p< 0.05

**Result of analysis of variance for growth parameter assessed:** The result of the ANOVA for growth parameters assessed shows that there was no significant difference in Plant height (0.13<sup>ns</sup>) among the locations while there was significant difference (0.00<sup>\*\*</sup>) between the period of data collection, there was significant difference (0.00<sup>\*\*</sup>) in the interaction between Location and duration of data collection. The result of collar

girth also reveals that there was significant different in location (0.03\*\*) and duration (0.00\*\*) at  $p < 0.05$ , the interaction between Location and duration of data collection also shows significant difference in collar girth. The Anova result of leaf production shows significant different in Location and duration (0.00\*\*) and the interaction between Location and duration (0.02\*) Table-2.

**Result of Correlation and Regression analysis of parameters assessed:**

The result of the correlation analysis showed that there was a significant correlation between the seed location and number of leaves (0.349\*\*), germination and plant height (0.656\*\*), germination and collar girth (0.203\*\*), germination and number of leaves (0.590\*\*). It also showed that there was a significant correlation between the number of leaves and leaf area (0.934\*\*), plant height and collar girth (0.147\*), plant height and number of leaves (0.577\*) and likewise there was a significant correlation between the collar girth and number of leaves (0.144\*) (Table-3). The result of the regression analysis on the effects of growth variables on tree plant height had coefficient of ( $R^2=0.930$ ). This therefore means that the assessed growth variables had about 93% effect on plant height of *Gmelina arborea* seeds collected from different locations within middle-belt Nigeria (Table-4).

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**Table-2:** Analysis of variance of parameters assessed.

Parameter assessed	Source of variation	Sum of squares	df	Mean square	F	Sig.	R <sup>2</sup>
Plant height	Location	111.59	2	55.79	2.04	0.132**	
	Duration	6625.32	2	3217.66	114.46	0.000**	
	Location*duration	937.99	4	234.49	8.58	0.000**	
	Error	7131.56	261	27.32			
	Total	324330.06	270				0.506
Collar girth	Location	8.31	2	4.15	3.55	0.03**	
	Duration	16.36	2	8.18	6.99	0.00**	
	Location*duration	3.17	4	0.79	0.67	0.60**	
	Error	305.14	261	1.17			
	Total	1709.32	270				0.084
Number of leaves	Location	438.76	2	219.27	34.19	0.00**	
	Duration	1210.34	2	605.17	94.37	0.00**	
	Location*duration	79.88	4	19.97	3.11	0.02**	
	Error	1673.56	261	6.41			0.508
	Total	93457.00	270				

**Table-3:** Correlation analysis for parameters assessed.

Source of variation	Seed location	Germination	Plant height	Collar girth	Num. of leaves
Seed location	1				
Germination	0.000	1			
Plant height	0.025	0.656**	1		
Collar girth	-0.141*	0.203**	0.147*	1	
Number of leaves	0.349**	0.590**	0.577**	0.144*	1

\*\*= correlation is significant at 1% level  $p < 0.01$ , \*= correlation is significant at 5% level  $p < 0.05$ .

**Table-4:** Regression analysis influence on the plant height.

	Un-standardized coefficient	Standardized coefficient	T			
Models	B	Std. error	Beta	B	Sig.	S.E.E.
(constant)	-37.60	3.954		-9.51	0.000**	
Location	0.216	0.123	0.040	1.765	0.079	
Duration	22.705	0.564	0.931	40.237	0.000**	
Collar girth	-0.262	0.595	-0.007	-0.440	0.660	
Number of leaves	0.154	0.238	0.014	0.649	0.517	0.930

Note: \*\* = highly significant at 1% probability level, \* = significant at p<0.05, ns = not significant, Dependent Variable: Plant Height. S.E.E mean Standard Error Estimate.

**Discussion:** The result of the study showed that seeds of *Gmelina arborea* collected from Nasarawa state Polytechnic Lafiahad the highest germination rate than other seeds sourced from Makurdi and Abuja as reported in Table-1, this could be ascribed to the fact that the seeds viability differ as a result of different climatic traits from the mother plants and also the seeds from this particular location were so vigorous in nature, since all the seeds from all the locations were subjected to the same treatment (drying and soaking) as it leads to rapid germination of seeds and establishment of the seedling. This agrees with the finding of Agboola and Etejere who reported that “drying and soaking is the most suitable treatment for releasing dormancy in *Gmelina arborea* seeds”<sup>11</sup>. The continuous growth noticed as at the period of data collection could be attributed to the fact the *Gmelina* stands is still at the sapling stage hence, growing at rapid rate. This is in accordance with the report of Rotowa *et al.* on *Moringa olifera* expose to fertilizer treatment<sup>12</sup>, also with Egbewole *et al.* on *Gmelina arborea* intercropped with agronomic plants on agro forestry plots<sup>2</sup> and Baligar *et al.* who reported the uptake of macronutrients to be significantly influenced by species, with time in a study he carried out at Beltsville Agricultural Research Centre, Beltsville, Maryland, in South America<sup>13</sup>. The difference in the nutrients uptake was attributed to differences in dry matter accumulation among different species. In his study, nine cover crop species were used and they showed a significant difference in growth parameters and nutrient uptake, influx, transport, and utilization efficiency at different time on different tree crop.

## Conclusion

It is evident from this research that the seeds vary in viability based on the location, as it was observed that seed collected from Lafia, Nasarawa state recorded more viability than the other two locations, therefore when raising *Gmelina arborea* seedlings for plantation establishment in middle belt Nigeria, seeds sourced from Lafia should be considered. Based on the

result of this study, It is recommended that further research be carried out on the pretreatment of *Gmelina arborea* seeds.

**Abbreviations:** G. Arborea: *Gmelina arborea*; ANOVA: Analysis of Variance, ns: Not Significant, N: North, E: East, DMRT: Duncan Multiple Range Test.

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