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Full Length Research Paper

Quantitative variations in the growth of progeny seedlings of *Prosopis africana* (Guill., Perrott. and Rich.) Plus trees in Nigeria

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Variations in the seedlings growth among the progenies of *Prosopis africana* Plus trees from four locations (Lafia, Makurdi, Ajaokuta and Oyo) in Nigeria were investigated. Seeds were sown in germination boxes under a high humidity propagator and at the two leaves stage after germination; the seedlings were transplanted into medium sized polythene pots (12 x 5 x 5 cm) containing top-soil. Assessment on the seedlings was carried out fortnightly for total height, collar diameter, number of leaves, leaf area and total biomass. Significant variation ($P \leq 0.05$) in seed germination among the locations with Oyo having the highest germination percentage (47.1%) after two weeks of sowing. There were no significant variations among the provenances for all the growth parameters considered except for total height. Mortality of the progenies due to an identified fungi infection differs among the location. Oyo progenies were the least susceptible to the fungi attack and it could be that they are naturally resistant to the attack.

Key words: Plus tree, progenies, *Prosopis africana.*

INTRODUCTION

Prosopis africana is the only tree of the 45-species genus that is native of Africa. The tree thrives in the savanna region of sub-sahara Africa. It is readily distinguished by its dark rough bark, pale drooping foliage with small pointed leaflets and sausage-shaped fruits. In Nigeria, it is known by such local names as Ayan (Yoruba), Ubwa (Igbo), Kiriya (Hausa) and Kohi (Fula). The matured trees normally range between 12 and 18 m in height, and may be up to 0.30 m in diameter (Keay, 1989). The wood is very hard and tough, rich red-brown, with grey sapwood. Its timber has been noted to have good physical properties in terms of dimensional stability and strength even than *Tectona grandis* (Jones and Taupiac, 2002). *P. africana* is a leguminous nitrogen-fixing tree. It provides fuel wood and fodder for livestock. Their seeds are processed into 'daddawa' cake, a popular product used for flavoring local dishes (Obeta and Ugwuanyi, 1996; Barminas et al., 1998). The pods and leaves also serve as forage for animals.

A typical forest tree improvement programme starts with selection of Plus trees (superior phenotypes) in a natural or planted forest. Progenies are then obtained from selected Plus trees and tested. Based on such tests, the best genotypes among the parents can be selected. Selected trees are multiplied by grafting and seed orchards are established. This present study is intended to be an offshoot and part of a *P. africana* improvement

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Table 1. Information on location of *Prosopis africana* plus trees.

Location	Latitude/longitude	Mean annual rainfall (mm)	Temperature (^oC)	Altitude (m)
Lafia	$8^o30'N$ $8^o34'E$	1100-2000	20 - 34	177
Makurdi	$7^o44'N$ $8^o35'E$	1500 -1800	23 - 31	97
Ajaokuta	$7^o26'N$ $6^o43'E$	1400 - 1800	23 - 32	54
Oyo	$7^o50'N$ $3^o55'E$	1250 - 1500	23 - 29	309

programme and the main objective is to assess the potentials of Plus trees that had already been identified and also identify traits that could be used to select promising progenies. Prior to this investigation, Plus adult trees of *P. africana* from four locations that spreads from west to east of the natural range in Nigeria was identified. Examining the potentials of their progenies is very crucial step towards obtaining a genetically improved variety of the tree species. This investigation was carried out at the nursery of the West African Hardwoods Improvement Project (WAHIP) at the Forestry Research Institute of Nigeria (FRIN), Ibadan, Nigeria.

MATERIALS AND METHODS

P. africana seeds were collected from Plus trees identified by Centre for Environment, Renewable Natural Resources Management, Research and Development (CENRAD), in four locations that spreads from west to east of the natural range in Nigeria. These locations are; Lafia, Makurdi, Ajaokuta and Oyo. Information on these locations is shown in Table 1. Six hundred seeds were collected from the Plus trees in all the four locations for the study. The first stage of the study was the assessment of the germination potentials of the seeds while the second stage was the growth assessment of the seedlings.

Seed germination

The seed germination assessment was carried out in Randomised Complete Block Design (RCBD) in three replicates and the sources of variation are Location and Pre-germination treatment. The experimental units which were 24 are in form seed germination boxes containing sterilized river sand. 100 seeds were sown into each germination boxes and then placed under a humidified propagator to provide a condition suitable for the germination of the seeds. Before sowing of the seeds, the seeds were pre-treated based on the recommendation of Ijomah and Udu (1998). To obtain optimum seed germination, recommendation of Ijomah and Udu (1998) were however modified by varying the soaking time of the seeds in H_2SO_4 from 10 and 20 min. The seed germination percentages in each of the germination boxes were recorded at interval of four days for 16 days.

Assessment of seedlings

The seedlings assessment was carried out in Completely Randomised Design (CRD), meaning that, the only source of variation is the location. Fifty seedlings from each location were pricked into polythene pots (12 x 5 x 5 cm) already filled with topsoil for growth assessment. Following variables were measured on the seedlings at the interval of two weeks for a period of twelve weeks; total height, collar diameter, number of leaves, leaf area and total biomass. Seedlings mortality due to a collar rot disease during the twelve-week assessment was also estimated. The collar rot infection was easily identified on the seedlings by the accumulation of a black substance in the collar region. This process led to the weakening of the seedlings at the collar region and they eventually fell off and die.

In order to normalise data distribution before data analyses, data collected through proportion and counting were transformed. Therefore, data on germination percentage were transformed by arcsine method while data on number of leaves were transformed by square root method. Detail procedure for the data transformation was described by Akindele (1996). Data collected were statistically analyzed using Statistical Package for Social Scientist (SPSS) for Windows (version 10.0).

Table 2. Result of the least significant difference of germination (%) of *Prosopis africana* across the locations.

Parameter	Mean
Locations:	
Oyo	47.1a
Lafia	47.0a
Ajaokuta	45.5a
Makurdi	27.4b
Duration of treatment:	
20 min	55.0a
10 min	21.7b

*Values with similar letters were not significantly different from each other at 0.05 level of significance and vice-versa.
**Values were mean of observed values.

RESULTS

Germination of the seeds after 16 days were generally low in all the locations as it ranges from 24 – 46%. However, the Analysis of Variance (ANOVA) carried out to compare the germination potential of the seeds from the locations and the pre-germination treatments applied revealed that there was significant difference ($P \leq 0.05$) among the locations and consequently, pre-germination treatments applied significantly affected the germination. Although the ANOVA revealed significant difference among the locations, result of the Least Significant Difference carried out further showed that there is no significant difference in the progenies from Oyo, Lafia and Ajaokuta (Table 2). The ANOVA carried out on the

seedlings growth using the growth variables showed that there were no significant differences at $P \leq 0.05$ among the locations except for total height. Further post-mortem analysis using the Duncan Multiple Range Test is presented in Table 3. Significant differences exist between Makurdi and other locations except Oyo.

The growth performance of the progenies after the 12 week assessment is presented in Table 4. Progenies from Ajaokuta had the highest collar diameter (0.22 cm), number of leaves (11) and leaf area (424.79 cm^2) values while Oyo progenies gave the highest total height value (14.39 cm). Makurdi progenies produced the highest total biomass (0.24 g). Cumulative growth performances during the 12 week assessment which is presented in Figures 1 to 5 showed that there were general increments in the growth variables across all the locations. Mortality of progenies due to the collar rot disease was found to be highest among Lafia progenies and lowest among Oyo progenies (Figure 6). It was observed that the mortality of progenies was largely due to an infection at the collar region of the seedlings. In examining the correlation among the tree parameters, a general positive and strong correlation was observed among the measured tree parameters. The correlations among the growth variables ranged between 0.56 and 0.88 (Table 5).

Table 3. Result of the multiple comparison of seedlings' height of *Prosopis africana* from different locations.

Locations	Mean
Ajaokuta	11.115[a]
Lafia	10.881[a]
Oyo	9.965[ab]
Makurdi	9.538[b]

*Values with similar letters were not significantly different from each other at 0.05 level of significance and vice-versa.
**Values were mean of observed values.

DISCUSSION

The low germination rate of the seeds may be attributed to the hard-coated nature of the seeds of leguminous tree species like *P. africana* (Willan et al., 1990). Nevertheless, attempt made in this study to modify the earlier recommendation of Ijomah and Udu (1998) yielded positive result. Ijomah and Udu (1998) in their work had earlier recommended soaking of the seeds in 98% concentration of H_2SO_4 for ten minutes In this study, soaking the seeds for 20 min in the 98% concentration of H_2SO_4 improved the seed germination. General increment in growth variables (i.e. number of leaves, collar diameter, seedling height, leaf area and biomass) during the 12 week assessment across the seed sources is an indication of growth, which is a common characteristic of biological organisms. This also showed that various meristematic cells in the seedlings are correlated

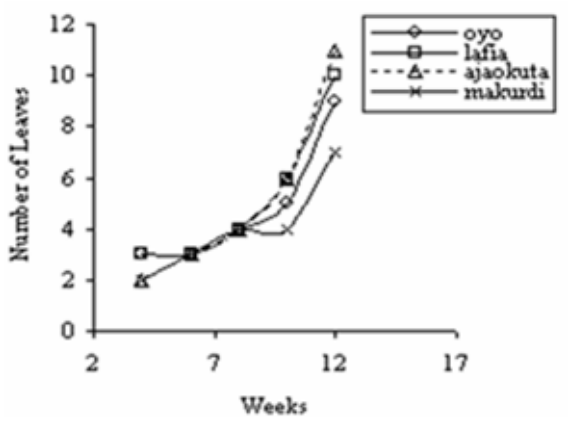

Figure 1. Mean number of leaves among the four *Prosopis africana* seed sources.

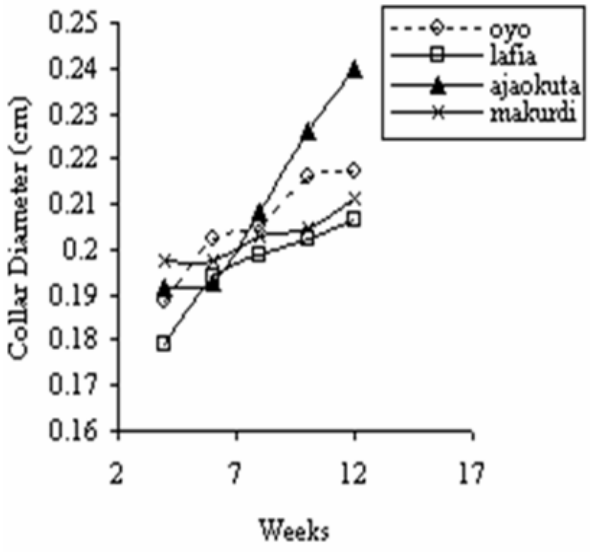

Figure 2. Mean collar diameter growth among the four *Prosopis africana* seed sources.

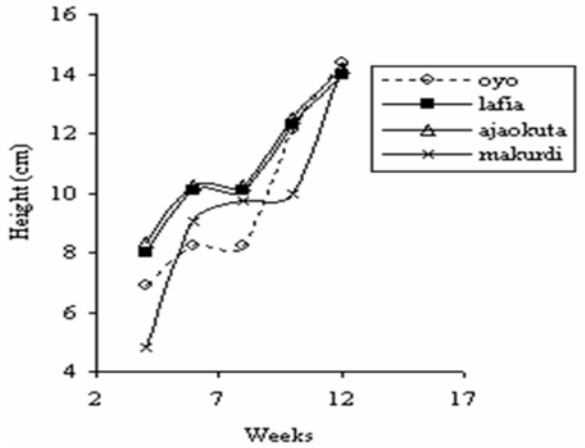

Figure 3. Mean height growth among the four *Prosopis africana* seed sources.

Table 4. *Prosopis africana* progenies growth performance after the 12-week assessment.

Locations	Growth variables				
	Total height (cm)	Collar diameter (cm)	Number of leaves	Leaf area (cm^2)	Total biomass (g)
Lafia	13.97	0.21	10	359.90	0.21
Makurdi	14.18	0.21	7	299.78	0.24
Ajaokuta	14.18	0.24	11	424.79	0.21
Oyo	14.39	0.22	9	304.55	0.22

*values presented are mean values

Table 5. Correlation matrix of some measured *Prosopis africana* growth variables.

Parameter	Leaf area	Height	No. of leaves	Biomass	Collar diameter
Leaf area	1				
Height	0.88388	1			
No. of leaves	0.87122	0.86471	1		
Biomass	0.63848	0.77122	0.802470023	1	
Collar diameter	0.74072	0.69642	0.742005583	0.562698091	1

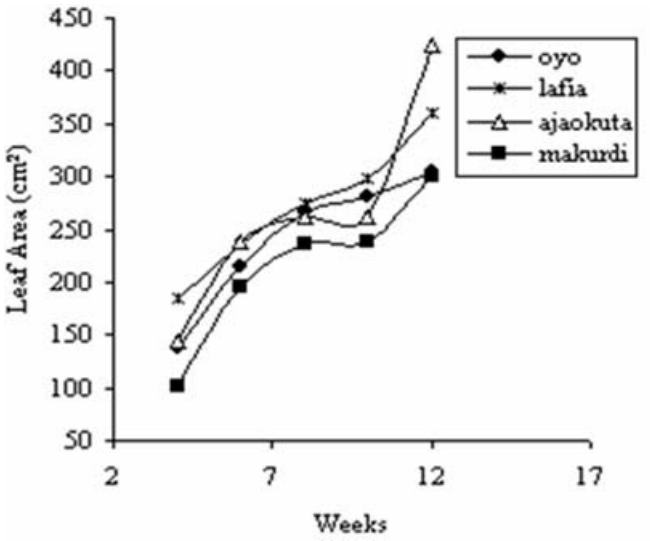

Figure 4. Mean leaf area growth among the four *Prosopis africana* seed sources.

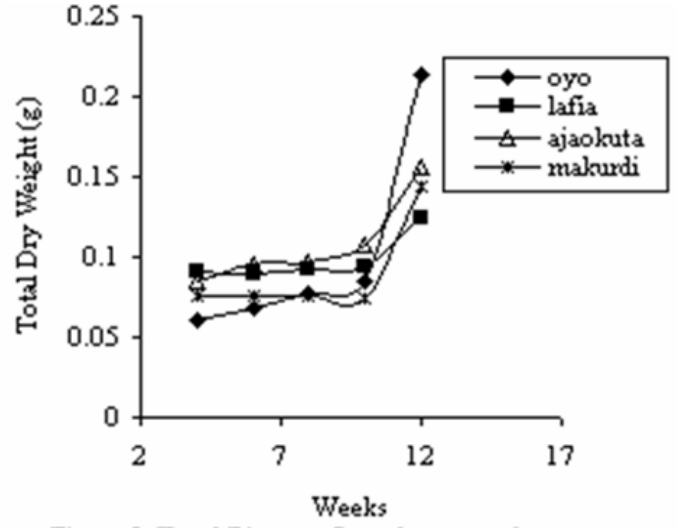

Figure 5. Total biomass growth among the four *Prosopis africana* seed sources.

based on the submission of Fogg (1970). Fogg (1970) asserted that the activities of the various meristematic cells are correlated; the correlation is such that as the shoot increases in length, it also increases in thickness and the root system extends proportionally.

The results of the Analysis of Variance (ANOVA) carried out to test the significance of variation at $P \leq 0.05$ among the progenies of different locations using the growth variables revealed that significant variation existed only in the seedlings' height. Variations in the growth of seedlings may be due to a genetic factor as claimed by Baker et al. (1979). They reported that early growth of tree seedlings have been traced to genetic factor of individual tree and less importantly to soil conditions, soil structures, weed competition and environmental factors. However, Mahoney and Fins (1995) further observed that seedlings height appear to be under a strong genetic control than other growth variables. Based on this report, it is expected that there should be no significant variation in growth variables of the seedlings among the locations except in the total height and that was the observation in the study. Therefore, seedling height could serve as trait for identifying genetically superior progenies. In addition, strong correlations that exist between height and other growth parameters further support that height could serve

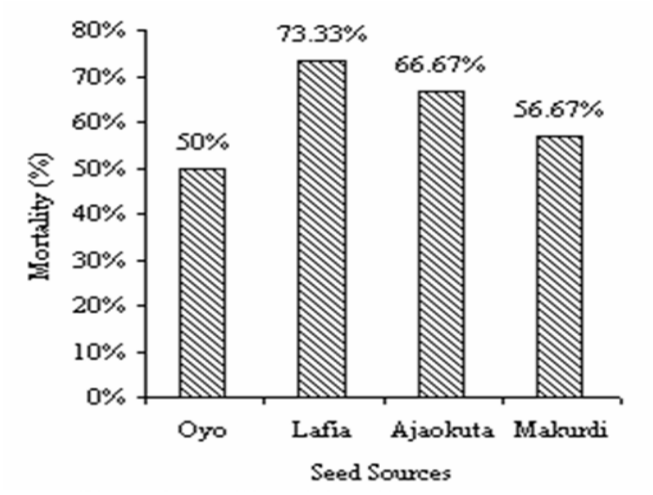

Figure 6. Seedling mortality among the four *Prosopis africana* seed sources.

as a trait for selecting superior progenies. The mortality of the progenies due to the collar rot disease in this study was generally high across the locations except Oyo where mortality of progenies is relatively average (50%). The collar rot disease is caused by a fungus identified to be *Macrophomina phaseolina.* The fungus attacked the collar region of the seedlings, which eventually became black due the accumulation of black pycnidia and the infected seedlings eventually died. Srivastava and Mishra (1993) made the similar observation while studying the diseases of *Prosopis juliflora* in India*.* They reported that seedlings of *P. juliflora* were attacked at the collar region by *M. phaseolina*. *M. phaseolina* has been noted to cause infection in the lower stem and roots of over 500 plant species (Partridge, 2005). It is then probable that seedlings that survived the fungi infection during the study are naturally resistant to it. Therefore, progenies from Oyo which has the lowest mortality rate can be said to be more resistant to the fungi infection than progenies from other locations.

Multipurpose trees like *P. africana* would produce variety of products than an industrial tree species and this call for range of possible improvement strategies. This study on the potentials of progenies of its Plus trees from different locations is a step towards this direction. Tree improvement of *P. africana* should involve combinations of multiple and desirable traits and this can be done in an improvement programme if there are strong and positive correlations among the desirable traits. Therefore, the strong and positive correlations recorded for most of the growth characters studied looks promising. Total height which differ significantly among locations and degree of resistance of *P. africana* seedlings to collar rot disease were traits identified and desirable for selecting superior progenies. Oyo progenies seem to be most promising in that they were the least susceptible to the collar rot infection identified in the study. However, further investigations assisted by molecular markers are recommended.

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