

DOI: <http://dx.doi.org/10.5281/zenodo.3980933>

Effect of growth media on the early performance of *Prosopis africana* (Guill. and Perr.) Taub. seedlings

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Received: 15 June 2020; Revised submission: 02 August 2020; Accepted: 05 August 2020



<http://www.journals.tmkarpinski.com/index.php/ejbr>

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ABSTRACT: This study examined the performance of *Prosopis africana* seedlings raised under different growth media. The experiment was laid in a completely randomized design with three treatments (topsoil, mixture of topsoil and poultry droppings, and mixture of topsoil and cow dung). Each treatment was replicated 4 times and each replicate had 10 potted seedlings making a total of 120 seedlings. The seedling growth variables; heights (cm) collar diameters (cm), number of leaves data were collected every 3 days for 12 weeks. The data collected were subjected to analysis of variance and significant means were separated using Duncan multiple range test at 0.05 significant level. The result showed significant difference ($p=0.005$) in the height of seedlings. No significant difference existed in the seedlings collar diameter ($p=0.306$) and number of leaves ($p=0.957$). The follow-up result indicated that there was no significant difference ($p>0.05$) in the height of seedlings raised in mixture of topsoil and poultry droppings (Mean \pm standard error = 105.87 ± 5.40^a) and topsoil (105.18 ± 4.27^a). However, a significant difference ($p>0.05$) existed between both treatments and mixture of topsoil and cow dung (86.36 ± 4.90^b). Seedlings raised in the mixture of topsoil and poultry droppings had the best performance. The study therefore, recommended raising *Prosopis africana* seedling with topsoil for reduced cost of production.

Keywords: Forest management; Growth media; Performance; *Prosopis africana*; Seedlings.

1. INTRODUCTION

Prosopis africana is a genus of flowering plants in the pea family, Fabaceae. It contains around 45 species of spiny trees and shrubs found in subtropical and tropical regions of the Americas, Africa, Western Asia, and South Asia. Its common names include African mesquite, iron tree, gele (Malinke) (traditional djembe wood) or Sombtree. *Prosopis africana* is a fairly slow-growing, deciduous tree with an open crown and drooping branches; it can grow from 4-20 m tall. Fermented seeds of *Prosopis africana* are used in Nigeria to prepare “Daddawa”, “Kpaye” or “Okpeye” fermented products used as food condiments [1].

Prosopis africana enriches the soil by fixing nitrogen; its leaves are rich in protein, and sugar pods are used as foodstuffs for feeding ruminants in Nigeria [2]. They often thrive in arid soil and are resistant to

drought, on occasion developing extremely deep root systems. The pulp of the pods contains 9.6% protein, 3% fat, and 53% carbohydrate and provides energy value 1168 J [3]. The wood has a high calorific value [4], so it is highly valued for charcoal by blacksmiths. The leaves, roots and especially the bark are used in traditional medicine. Similarly, *P. africana* is used in the preparation of foods such as soup and baked products and in the manufacture of sausages or sausages and cakes. *P. africana* is becoming weaker in its range because of excessive overexploitation, by cutting the stems and branches of it, which limits its natural regeneration capacity [5].

Growing media are materials that plants grow in which are specifically designed to support plant growth and can either be a solid or a liquid. Different components are blended to create homemade and commercial growing media. Growing media has three main functions which are; supply roots with nutrients, air and water, allow for maximum root growth and physically support the plant [6].

According to Agbo and Omaliko [7] the quality of nursery seedlings depends largely on the growing media. The performance of seedlings when planted out in the field is determined by their performance in the nursery [7]. Quality of a growing media used to raise containerized seedlings is a key determinant factor to successful tree planting program [8]. The selection of a proper media component is critical to the successful production of seedling because it directly affect the development and later maintenance of the extensive functional system [9]. In earlier by Faye et al. [10], they pointed that *Prosopis africana* is a particularly vulnerable species, as it is not cultivated therefore facing the danger of going into extinction. It is therefore necessary to determine the growth media to be used to propagate the plant. The main objective of this study is to determine the effect of different growing media on the seedling growth performance of *Prosopis africana*.

2. MATERIALS AND METHODS

2.1. Study area

This study was carried out in the Prof. E.L.C Nnabuife screen house of the Department of Forestry and Wildlife, Nnamdi Azikiwe University, Awka. The University is located in the South-eastern geopolitical zone of Nigeria and lies between latitude 6.245° to 6.283° N and longitude 7.115° to 7.121° E (Figure 1). It is a tropical region, has an average annual temperature of 26.3°C with a rainfall pattern ranging from 1828 mm – 2002 mm. It lies below 300 m above sea level in a valley on the plains of the Mamu River. It is sited in a fertile tropical valley but most of the original rain forest has been lost due to clearing for farming and human settlement [11-12].

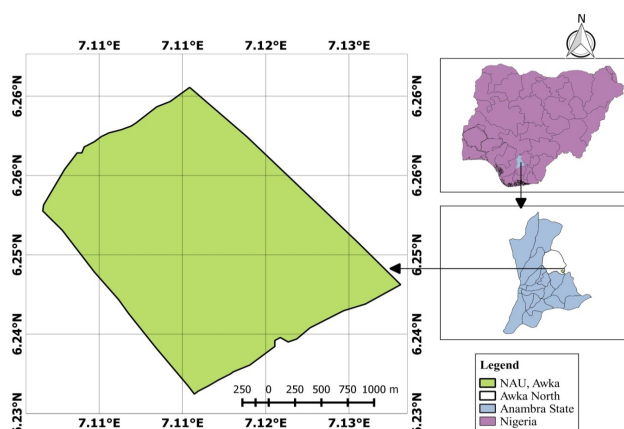


Figure 1. Map of Nnamdi Azikiwe University, Awka, Nigeria. Based on [11].

2.2. Seed collection

Viable mature seeds of *Prosopis africana* (Guill. and Perr.) Taub. were collected from three mother trees at Tse–Anuba village along University of Agriculture-Gbajimba road, Makurdi Local Government Area of Benue State, Nigeria. The seeds were treated with tetraoxosulphate (VI) acid 30 minutes and germinated as recommended by Uleh and Fagbemi [13] and Chukwu et al. [14].

2.3. Experimental design

The experiment was laid in a completely randomized design (CRD) with three (3) treatments (T); T1 (control) = Topsoil, T2 = mixture of topsoil and poultry droppings at ratio of 2:1 and T3 = mixture of topsoil and cow dung at ratio of 2:1. Each treatment was replicated 4 times and each replicate had 10 potted seedlings making a total of 120 seedlings. Table 1 showed the experimental layout used for the study. Samples of both the un-amended (control) and amendment growing media were collected to test for their physico-chemical properties following the procedure adopted by Egwunatum et al. [15]. The 120 healthy seedlings of relatively equal heights were then potted in to 26 cm × 21 cm polythene-pots filled with loamy sand soil (topsoil) and various amended soils with poultry droppings and cow dung. The plants were arranged in the screen house and watered twice daily (morning and evening).

Table 1. Experimental layout.

	R1	R2	R3	R4
T1	T1R1	T1R2	T1R3	T1R4
T2	T2R1	T2R2	T2R3	T2R4
T3	T3R1	T3R2	T3R3	T3R4

Where: T = treatments, R = replicate, T1 = Topsoil, T2 = mixture of topsoil and poultry droppings, T3 = mixture of topsoil and cow dung.

2.4. Data collection and analysis

Data seeding growth variables were collected third daily and data collection lasted for twelve (12) weeks. Seedling heights were measured from the apical bud of the plants to the shoot using veneer caliper, number of leaves were enumerated by ocular estimation and collar diameters were measured using digital veneer caliper.

The data collected were subjected to analysis of variance (ANOVA). For the purpose of analysis of variance, the numbers of leaves were transformed into arcsine values [16]. Significant means were separated using the Duncan Multiple Range Test (DMRT) at 0.05 significant level.

3. RESULTS

The result of soil test was shown in Table 2. The organic carbon and organic matter content of the soil were increased after the in T2 (2.21 and 4.10, respectively) and T3 (2.15 and 4.03, respectively). The pH, Nitrogen, Calcium, Magnesium, Sodium and Potassium content of the growing media increased after mixing the soil with poultry droppings and cow dung, respectively (Table 2). The test result for texture of the topsoil used as control and for mixing organic manure consist of sand = 86.8%, silt = 5.4% and clay = 7.8% clay, these indicated a loamy sand soil type.

The result of ANOVA for *Prosopis africana* seedlings under different growth media showed significant difference ($p < 0.05$) in the height of seedlings. No significant difference existed in the seedlings collar diameter ($p = 0.306$) and number of leaves ($p = 0.957$). The DMRT result for growth height revealed that the

mixture of topsoil and poultry droppings (T2) had the highest mean of 105.87 cm \pm standard error (SE) = 5.40 cm, followed by topsoil (T1) with mean = 105.18 \pm 4.27 cm and mixture of topsoil and cow dung (T3) with Mean = 86.36 \pm 4.90 cm. T2 also had the highest Mean = 0.8659 \pm 0.04 cm for collar diameter, followed by T1 (Mean = 0.8242 \pm 0.03 cm) and T3 (Mean = 0.7886 \pm 0.03 cm). In the case of number of leaves, T2 had the highest (Mean = 8.6633 \pm 0.50) followed by T3 (Mean = 8.5975 \pm 0.42) and T1 produced the lowest (Mean = 8.4761 \pm 0.38) (Table 3).

Table 2. Chemical characteristics of growing media.

	pH	N	OC	OM	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	H ⁺	Al ³⁺	CEC	Ca/Mg
	(H ₂ O)	(%)	(%)	(%)	meq/100g soil							ratio
T1	6.31	0.16	1.92	3.23	32.71	5.03	0.17	0.31	8.91	10.44	57.57	6.50
T2	6.41	0.22	2.21	4.10	27.98	4.44	0.21	0.32	4.78	5.89	43.62	6.30
T3	6.33	0.21	2.15	4.03	29.42	4.41	0.19	0.28	4.71	5.81	44.82	6.67

Where: T = treatments, T1 = Topsoil, T2 = mixture of topsoil and poultry droppings, T3 = mixture of topsoil and cow dung.

Table 3. Results for the growth variables of *P. africana* seedlings under different growing media.

Treatment	Seedling growth variables (Mean \pm Std. error)		
	Collar diameter (cm)	Number of leaves	Height (cm)
T1	0.8242 \pm 0.03 ^a	8.4761 \pm 0.38 ^a	105.18 \pm 4.27 ^a
T2	0.8659 \pm 0.04 ^a	8.6633 \pm 0.50 ^a	105.87 \pm 5.40 ^a
T3	0.7886 \pm 0.03 ^a	8.5975 \pm 0.42 ^a	86.36 \pm 4.90 ^b

Where, T1 = topsoil, T2 = mixture of topsoil and poultry droppings and T3 = mixture of topsoil and cow dung. Means with the same alphabets had no significant difference at 5% probability level.

The follow-up result also indicated that there was no significant difference ($p > 0.05$) in the height of *Prosopis africana* seedlings raised in the mixture of topsoil and poultry droppings and ones raised in topsoil. However, a significant difference exists between seedlings raised in mixture of topsoil and poultry droppings and in mixture of topsoil and cow dung (Table 3).

4. DISCUSSION

Woody plants have played, for centuries, an important socioeconomic role for rural populations in West Africa, particularly Nigeria. Most species playing this socioeconomic role are subject to high anthropogenic pressure reducing their natural regeneration [17]. *Prosopis africana* is a species with domestic uses that are of inestimable importance. The leaves and pods are used by farmers for animal food and the bark and roots are used to treat diseases [18]. Its wood is very resistant to decay and is used to make household tools (mortars and pestles), poles for construction and charcoal, which is highly appreciated by blacksmiths [19]. From the result of this study, the soil's physical and chemical properties of the growing media were greatly influenced by addition of poultry droppings and cow dung to the topsoil. Similar result was reported by Egwunatum et al. [15] that amended forest soil using different organic manures.

The study revealed no significant difference was recorded for both collar diameter and the number of leaves of the seedlings under the different growth media. This supports the findings of Peter-Onoh et al. [20] on *Tetrapluera tetraptera* that there is no significant difference for the number of leaves under different growth media. The result for growth height, the mixture of topsoil and poultry droppings produced the highest mean, followed by topsoil and mixture of topsoil and cow dung. This is in agreement with Naishima et al.

[21] on the early growth of *Eucalyptus camaldulensis* who recorded that treatments with poultry droppings gave the highest plant height and Onwubiko et al. [22] on *Pentaclethra macrophylla* who reported that the least mean height was obtained in a mixture of topsoil and cow dung. It also corroborates the findings of Okunomo [23] on the germination and seedling growth of *Parkia bicolor* who also recorded the highest height in treatments with poultry droppings as opposed to the other treatments. Poultry manure is the faeces of chickens used as an organic fertilizer, especially for soils low in nitrogen. Of all animal manures, it has the highest amount of nitrogen, phosphorus, and potassium [24].

5. CONCLUSIONS

This research provided a better understanding of the best means of propagating *Prosopis africana* from its seeds. Based on the result of this experiment, seedlings raised in mixture of topsoil and poultry droppings had the highest mean values for the growth variables investigated. However, mean values of the growth variables of seedlings raised in a mixture of topsoil and poultry droppings did not differ significantly from those seedlings raised in topsoil. Hence, this study recommends the use of topsoil to save the cost of seedling production and planting in plantations to enhance conservation of the depleting resource; since there was no significant difference between the performance of seedlings grown in topsoil and the mixture of poultry droppings and topsoil. This study also recommended that further research should consider analyzing the soil physicochemical properties of the growth media.

Authors Contribution: This work was done in collaboration among the authors. PUA and OC designed and supervised the study, statistical analysis, interpretation of data and reviewed the manuscript. CIE, FCI and MAU worked on literature searches, data collection and writing of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest: The authors have no conflict of interest to declare.

Acknowledgment: The authors appreciate the Department of Forestry and Wildlife, Nnamdi Azikiwe University, Awka, Nigeria for providing material and technical support towards the success of this research work.

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