



(KEJAANS)

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES

January, 2025 Vol. 1, issue 1



KEJAANS

CONTACT:

The Editor,
Kebbi Journal of Agriculture and Natural Sciences,
Faculty of Agriculture,
Kebbi State University of Science and Technology Aliero,
PMB 1144, Birnin kebbi, Nigeria.
Email: kejaanseditor@ksusta.edu.ng, kejaans.foa@gmail.com.
Phone: +234 8039370546

ISSN: 1595-5776



KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES
(KEJAANS)

JANUARY, 2025: Volume 1, Issue 1

OFFICIAL JOURNAL OF THE
FACULTY OF AGRICULTURE
KEBBI STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY, ALIERO

Editors

**I.S. Jega
M.I. Ribah
I. Sani
M. Atiku
M.N. Kwaifa**

KEJAANS

ISSN: 1595-5776

(c) 2025

About the Journal

This official scientific publication of the Faculty of Agriculture, Abdullahi Fodiyo University of Science and Technology Aliero, is a non-profit, open access, double-blind peer-reviewed Journal publishing four issues (January, April, July and October) per annum. The Journal is a platform open to collaborations with researchers, authors, institutions, research agencies and private companies related to Agriculture. The Mission of the Journal is to disseminate scientific knowledge through the publication of original research articles, research notes, book reviews, letters to the editor and reviews of Literature, representing a contribution to scientific and technological knowledge in respective areas covered by the Journal. The Kebbi Journal of Agriculture and Natural Sciences seeks to validate and disseminate new knowledge, making it public in order to strengthen the human capacity, constitute a link in the scientific community to the society and encouraging the expansion of University and academic researches.

Scope of Kebbi Journal of Agriculture and Natural Sciences (KEJAANS)

The Kebbi Journal of Agriculture and Natural Sciences has the sole aim of providing an intellectual platform and ideas for scholars, by promoting interdisciplinary studies related to agriculture and natural science through publishing the latest scientific research findings that are of direct policy implications and beneficial to the research community. Consequently, the journal covers all aspects of Crop Science, Animal Science, Agricultural Economics, Agricultural Extension and Rural Development, Food Science, Fisheries and Aquaculture, Biotechnology, Soil Science and Agricultural Engineering, Forestry and Environment, Wildlife, Agricultural Education, Agro-allied Industries as well as all Natural Science researches related to Agriculture.

KEJAANS

INSTRUCTIONS FOR AUTHORS

Submission of Manuscript

Submission of manuscript to JAANS shall be on an online platform. Papers could also be submitted as e-mail attachment to the Editor-in-Chief using the kejaanseditor@ksusta.edu.ng or kejaans.foa@gmail.com. The paper should be submitted as a single file in Microsoft Word Format (no other formats will be accepted) and the file shall not be more than 5 Megabytes so that it can be e-mailed to reviewers. The first author, month and year of submission shall be the file name (e.g Ibrahim *et al.* Aug 2010 doc). Once the Editorial Board receives the submission, acknowledgement shall be sent to the corresponding author. If acknowledgement of submission is not received within a week, the author shall remind the Editor-in-Chief through the official email.

Preparation of Manuscript

General presentation: The manuscript should be presented clearly and concisely in English Language. Manuscripts must be prepared (preferably with MS word package) using 12-point New Times Roman (TNR) font, double line-spaced on A4 size paper (210 — 297mm) with at least 3cm margins on all sides. All typing should be justified. Pages including figures and Tables, should be numbered consecutively in the bottom middle with the title page as page 1. Manuscript should contain the following sections (except for review and commentary articles): **Title page; Abstract; Introduction; Materials and Methods; Results, Discussion (Results and Discussion could be combined); Conclusion and References.**

Title page

The first page of the manuscript should contain the title of the article, which should be concise and explicit, typed with upper-case, bold, 14 font size, TNR and not more than 21 words. The surname and forenames (in full) of authors, affiliation of each author should be provided. Phone number and email address of the corresponding author (identified by an asterisk) should be provided. Superscripts should be used to relate authors to their affiliations.

Abstract

The next page should contain abstract in English. Abstract should not be more than 250 words and should provide sufficient information to give the reader a full understanding of the content of the article. Paragraphs, footnotes, references and undefined abbreviations should be avoided.

Keywords

Up to five keywords in normal fonts, separated by semi-column, should be provided to assist the reader and facilitate information retrieval.

Body of Text

The title of the article should be typed in upper-case letters and bold. All other headings should be typed in upper-case letters and bolded while sub-headings should be in lower-case and bolded. The main headings should not be indented. The SI unit system must be used. Standard abbreviations may be used without definition, and specialized abbreviations should be used only after they are defined when they first appear. Use capital 'T' for Table and 'F' for figure. Mathematical formulae should be carefully typed with symbols, correct alignment and must be adequately spaced. Statistical evaluation of results should be described briefly and if necessary, supported by references.

Introduction

A concise introduction of the background to the subject is required and should include a brief statement of the problem, significance and purpose of the research and relationship to earlier works with well acknowledged references.

Materials and Methods

This section must be presented with adequate clarity and provide sufficient details to permit the repetition of the experimental work. The techniques and the methodologies adopted should be supported with standard references. Subheadings under this section should be in lower case except the first letter.

Results and Discussion

Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both Table and figure. In discussion, point out the significance of the results and place the results in the context of other work and theoretical background. Results and Discussion part could be written separately if author so wish.

References

Only published articles (Journals and Proceedings) or Books may be cited. In addition, articles with evidence of Journal acceptance are considered as "in press" and are also citable. The reference list should be arranged alphabetically. Authors should be referred to in text by name and year (Harvard system). Examples:

For Journals, list as:

Jega, I.S. and Kwaifa, M.N. (2017). Statistics of Cassava Yield Trials with the Additive Main Effects and Multiplicative Interaction (AMMI) model. *African Journal of Root and Tuber Crops*, 3 (1), 46-50.

Within the text, references should be given as: Meaza *et al.* (2007), or similar results have been obtained (Meaza *et al.*, 2007).

For proceedings, list as:

Aina, O.O., Dixon, A.G.O. and Akinrinde, E.A. (2021). Influence of shoot and root characteristics of cassava genotypes on yields in Nigeria. *African Crop Science Conference Proceedings*, Vol. 5. pp. 1119-1125.

For Books, list as:

DeVries, J. and Toenniessen, G. (2001). *Securing the Han/est Biotechnology, Breeding and Seed Systems for African Crops*. The Cromwell Press, Trowbridge, Wiltshire, UK. 208pp.

For electronic resource materials (online publications) list as:

Zachary, G.P. *Africa plays the rice card*. Foreign Policy. May/June 2008 (web-exclusive story). http://WWW.foreignpolicy.com/stogg/cms.php?story_id=4306. Accessed 26 August 2008.

Tables and Figures

Tables and Figures should be labelled serially using Arabic numerals (e.g Table 1, Table 2, etc; Figure 1, Figure 2, etc.)

Abbreviations

Avoid the use of abbreviations at the beginning of the title, heading or sentence. The following abbreviations with numerals can be used without spelling out at first use. H, min, s, yr, mo, mm, kg, g, DNA, RNA, cpDNA, dNTP.

Numbers

Avoid the use of figures /numbers at the beginning of a sentence. Write out one through nine unless a measurement, a designator, or a range (e.g five seeds, 8cm, 3yr, 5-11 flowers)

Ethical matters

The author using experimental animals must seek permission and include a statement that the investigation was approved by the Ethics Clearance Committee of the researchers' institution.

Copyright

Submission of a copyright to **KEJAANS** implies that the study presented has not been published before or under consideration for publication elsewhere. Once an article has been accepted for publication, author concedes the copyright to **KEJAANS**. However, authors are responsible for the content that appeared in their manuscripts.

Plagiarism Check on Submitted Papers

Since academic Journals must strictly audit the quality of the papers, prevent plagiarism, fraud and other phenomena, ensure that the papers are scientific, original and standardized; cultivate the author's research integrity and consciousness in the process, create a healthy and fair academic environment. It is advisable that each author first conduct a plagiarism check on their paper before submission. Every submitted paper undergoes a plagiarism check by the editors. The editors of **KEJAANS** shall liaise with the Academic Librarians of the organization/institution to do this. Any paper that is more than 20% (or less as determined by the editors) in its plagiarism check shall be sent back to the author for reworking and resubmission.

Blind Peer-review of Submitted Papers

Submitted papers that passed a plagiarism check by **KEJAANS** shall be sent to at least two reviewers that are expert in the field, after every piece of information that can reveal the identity or the affiliation of authors has been concealed for fair, blind peer review. The reviewers shall give a comprehensive report of their review. The editors shall design a Form to be completed by the reviewers after the review. The reports and completed forms shall guide the editors in their further decisions on the reviewed article. The reviewers shall recommend the paper for publication or otherwise.

Publication of Papers

This shall be done after the acceptance of articles for publication in line with the next publication time of the Journal. Prior to publication, a galley proof copy shall be sent to the corresponding author who shall immediately effect correction (if any), and return to the editors. The number of articles to be published in a given issue of the Journal shall be at least 15. It is not compulsory for **KEJAANS** to produce an issue of the Journal if there are no accepted articles ready for publication at a given time of publication.



PROFILE DISTRIBUTION OF SELECTED SOIL PROPERTIES AS INFLUENCED BY TREE SPECIES IN MINNA, SOUTHERN GUINEA SAVANNA, NIGERIA

*SHARIF, Labaran Musa, TSADO, Philips Alkali and LAWAL, Baba Abubakar

¹Department of Soil Science and Land Management, Federal University of Technology, Minna, Niger State, Nigeria

*Corresponding author: Musasharif2017@gmail.com 07019237628; 08174728276

ABSTRACT

This study assessed the effect of tree species and soil depth on selected soil physical and chemical properties in the arboretum of the Federal University of Technology, Minna, Nigeria. Three mini soil profile pits were excavated under each land use type namely: teak, gmelina and eucalyptus plantations and the arable field (control) and soil samples collected at regular depth intervals of 0-20, 20-40 and 40-60 cm. The experimental design was 4 x 3 factorial fitted into Randomised Complete Design (RCD) with 3 replications. A total of 36 soil samples were collected and analysed in the laboratory following standard analytical procedures. Data were subjected to analysis of variance (ANOVA) and means were separated using LSD (5%). Correlation analysis was conducted to determine the relationship among soil properties. Results indicated darker soil colour in soils under gmelina and teak than eucalyptus and the control. Significant ($P < 0.05$) effect of tree species on levels of sand, clay, pH, organic carbon (C), total nitrogen (N) and available phosphorus (P) was recorded while silt and potassium (K) were not significantly different. Soil depth affected ($P < 0.05$) distribution of all the parameters determined except pH and K. Sand showed significant and inverse correlation with silt ($r = -0.66$) and clay ($r = -0.76$). Organic C had significant positive correlation with total N ($r = 0.36$) and available P ($r = 0.85$) and negative correlation with K ($r = -0.43$). None of the tree species was all round outstanding in terms of soil quality invigoration. While gmelina and teak were superior in improving soil N and protecting soil texture and structure, eucalyptus was a promising candidate in soil organic C replenishment. In order of priority, the study recommends teak > gmelina > eucalyptus in afforestation for soil health improvement in Minna, Niger State.

Keywords: Tree species, arable field, soil properties, soil depth, southern Guinea savannah

Introduction

Forest plantations are stands of tree species established, where previously there was none, through planting during the processes of afforestation. Whether planted as stands of mixed- or mono-species, forest plantations can

have effects on soil properties. In Nigeria, especially, in savannah ecosystem, tree species like Teak (*Tectona grandis*), Gmelina (*Gmelina arborea*), and Eucalyptus (*Eucalyptus camaldulensis*) are widely used in afforestation programme. These species are

globally acknowledged as excellent for soil improvement due to some quality attributes such as faster growth habit, tolerance to adverse climate and edaphic factors in addition to their assured economic returns (Ota *et al.*, 2018; Akinde *et al.*, 2020; Yimam *et al.*, 2024). These attributes generated interest on studies related to their impact on soil properties whether they are established mixed- or mono-species, in the same climatic conditions having similar parent material (Hu *et al.*, 2024).

Numerous investigations have documented with increasing evidence suggesting the effects of tree species on soil properties (Dawud *et al.*, 2017). Earlier investigations on the effect of species revealed changes in soil physical and chemical properties such as pH, cation exchange capacity (CEC), and nutrient status, that is, nitrogen (N) and phosphorus (P) stocks (De Vries *et al.*, 2003). Even under identical soil and environmental conditions, planting different tree species as monocultures resulted to substantial variations in soil properties (Binkley and Giardina, 1998). A similar study under mixed forests stand also discerned the influence of individual tree species on soil properties, particularly in the surface soil layer (Kooch *et al.*, 2017). Furthermore, studies by Augusto *et al.* (2015) also reported variations in soil moisture, soil carbon storage, the carbon to nitrogen (C/N) ratio, and pH under different monoculture of forest stands.

However, serious concerns have been raised regarding to the impacts of different tree species on soil physical, chemical, morphological and biological properties vis-a-vis sustainability of plantation sites (Onyekwelu *et al.*, 2006). For example, a monoculture stands of Eucalyptus, for instance, plays a vital role in the improvement of soil physical and chemical properties (Mishra *et al.*, 2003). Also, a study by Amsalu (2019) showed that Eucalyptus stands had a significantly higher effect on soils; haven increased its sand and lowered the clay

contents. These negative effects of Eucalyptus species on soil properties, in addition to its high nutrient demand and extraction from the soil reduces soil quality (Niyompuhwe *et al.*, 2023). Unlike Eucalyptus, Gmelina plantations have been proved to be a good soil modifier in terms of stabilization of soil nutrients (Mishra *et al.*, 2003).

Despite the importance of soil properties in tree growth and ecosystem health, little research has been done as it relates to the effects of tree species and soil depth on soil properties in the North-central zone of Nigeria, particularly in Niger State. The few documented studies by Adeboye *et al.* (2011) was limited to soil organic carbon, total nitrogen and microbial properties under the forest ecosystem, while Lawal *et al.* (2014) worked on soil properties as influenced by slope positions under the Teak plantation only. This gap in knowledge hinders the ability of researchers, local authorities and farmers to make informed decisions about tree planting, choice of appropriate tree species and soil management practices. To safeguard and maintain the sustainability of the soil under forest plantations, it is imperative to evaluate the effects of Teak, Gmelina and Eucalyptus and soil depth on the soil properties such as particle size distribution, pH, organic carbon (C), total nitrogen (N), available phosphorus (P) and exchangeable potassium, hence the need for this study using the arboretum of the Federal University of Technology, Minna a case study.

Materials and Methods

The Study Site

The study was conducted at Forest Plantation (Arboretum) of the Federal University of Technology, Minna, Niger State, located at kilometre 20, along Minna – Bida highway (Figure 1). The site was geographically identified on Latitude 09° 31' 18.2" N and Longitude 6° 27' 39.6" E and lies on average

contamination) using a hand trowel. Well-labelled soil samples were sent to the laboratory for routine analysis.

Laboratory Analysis

Soil samples collected from the field were air-dried in the laboratory, gently crushed using a mortar and pestle, and sieved through a 2 mm sieve to obtain fine earth separates. The processed soil samples were analysed following the standard laboratory procedures as indicated in the International Institute of Tropical Agriculture (IITA) Laboratory Manual (IITA, 2015), and briefly described as follows. Particle size distribution was determined by Bouyocous hydrometer method, soil pH in 1:2.5 soil to water suspension ratio was determined by Beckman's glass electrode pH meter. Organic carbon (OC) was determined by Walkley-Black dichromate wet oxidation method, available phosphorus (P) by Bray P 1 method and total nitrogen (N) by Micro-Kjeldahl method. Neutral ammonium acetate (1N NH₄OAc) solution was used in extraction of exchangeable potassium (K⁺) and amount of K

in the solution was measured using flame photometer.

Data Analysis and Interpretation

Data obtained from laboratory analysis was subjected to Analysis of Variance (ANOVA) using SAS statistical package (SAS Institute, 2015). Significant differences among treatment means were separated using LSD at 5% level of significance. Pearson correlation analysis was conducted to test for relationships among the soil properties. Interpretation of soil chemical properties was based on the fertility ranking by Chude *et al.* (2011).

Results and Discussion

Soil Colour as influenced by Tree Species and Soil Depth

Results of soil colour description as presented in Table 1 are under three components, the hue, value and chroma. Hue is the dominant spectral colour, value expresses relative brightness or darkness of colour, while chroma defines the gradations of purity of colour.

Table 1: Soil colour as influenced by tree species and soil depth

Soil Depth (cm)	Teak	Gmelina	Eucalyptus	Arable field (control)
0-20	10YR 3/3 Dark brown	10YR 3/4 Dark yellowish brown	10YR 4/2 Dark greyish brown	10YR 4/6 Dark yellowish brown
20-40	10YR 5/3 Brown	10YR 4/6 Dark yellowish brown	10YR 6/2 Light brownish grey	10YR 5/6 Yellowish brown
40-60	10YR 6/4 Light yellowish brown	10YR 5/6 Yellowish brown	10YR 5/2 Greyish brown	10YR 5/1 Gray

All pedons, irrespective of soil depth, reflected hue of 10YR (yellow-red) colour spectrum. The topmost layer 0-20 cm, was characterized

by dark yellowish brown in gemlina (10YR 3/4) and the control (10YR 4/6), dark brown (10YR 3/3) in teak and dark greyish brown

(10YR 4/2) in eucalyptus stands. The layer had a darker colour value of 3 was under the gmelina and teak stands, and value of 4 for the eucalyptus stand and the control. Dark colours are typical of A-horizon, that is, surface layer (Soil Survey Division Staff, 2017) and often indicates substantial amount of decomposed organic matter referred to as humus (Minh *et al.*, 2023). The variation (trend) of soil colour as influenced by land use type was gmelina=teak>eucalyptus=control. This may be linked to the deciduous nature of the gmelina and teak which allowed for their seasonal shedding of leaf-litters accompanied by decomposition leading to higher organic matter content in the soil (Egwunatum *et al.*, 2015; Ota *et al.*, 2018) as compared to the eucalyptus and the control. The purity (colour saturation) of the soil colour revealed moderate chroma of 4, 3 and 6 under the gmelina, teak and control, while eucalyptus was had chroma of 2, a subdued colour associated with poor drainage.

The subsurface colours were lighter in colour in all profiles and revealed brown (10YR 5/3) colour at the depth of 20-40 cm in teak, dark yellowish brown (10YR 4/6) gmelina, light brownish grey (10YR 6/2) in eucalyptus and yellowish brown (10YR 5/6) in the control. The lightness could be explained in terms of the pedogenic history of the soils and or their natural drainage characteristics (Brady and Weil, 2002; Soil Survey Division Staff, 2017). The Munsell colour values ranged from 4 to 6 and reflected a decreased trend in colour darkness as gmelina>teak=control>eucalyptus. Also, by comparison, soil colour at 20-40 cm depth was lighter than the topmost layer. The chroma of 6, 3 and 2 corresponded to moderate saturation of soil colour expressed under gmelina, teak and the control and low in eucalyptus stands. Similarly, at depth of 40-60 cm, the profiles had light yellowish brown (10YR 6/4) colour in teak, yellowish brown (10YR 5/6) in

gmelina, and greyish brown (10YR 5/2) in eucalyptus and grey (10YR 5/1) in the control. In the same order, the moderate Munsell values of 6, 5, 5 and 5 indicated a medium-dark tone (neither very dark nor very light) in under all the land use types. Moderate chroma of 4 and 6 under the gmelina and teak stands indicated a well-drained soil while chroma of 2 recorded under the eucalyptus and control indicated waterlogged conditions.

Effects Tree Species and Soil Depth on Particle Size Distribution

The results of the effects tree species and soil depth on particle size distribution are presented in Table 2. The effect of tree species on sand and clay contents were significantly ($P<0.05$) different, except on silt ($P>0.05$) where the means were similar. Sand content of the soil under Eucalyptus was significantly ($P<0.05$) higher than that under Gmelina, Teak and the arable field (control). Clay fraction in the soil was significantly ($P<0.05$) lower in Eucalyptus than the other species and the control. These differences could be linked to the architectural nature of the species canopies since the soils were believed to have developed under similar conditions of parent material, climate, micro-relief and time, except variations in their vegetative cover. Thus, the current findings strongly corroborated with the findings of Amsalu (2019), who reported that *Eucalyptus* species has effect on soils by significantly increasing the sand and lowering the clay contents when compared to other tree species. Soil depth impacted significant ($P<0.05$) differences on content of sand, silt and clay across the layers. Sand was significantly ($P<0.05$) higher at the surface layer (0-20 cm depth) and lowest in the subsurface layer (40-60 cm depth) revealing a distribution pattern of 0-20 cm > 20-40 cm > 40-60 cm. Silt was highest at the subsurface 40-60 cm depth while 0-20 and 20-40 cm were statistically similar. Clay was lowest at the surface layer (0-20 cm

depth) and significantly ($P < 0.05$) increased with increased soil depth. These differences could be attributed to sorting of finer soil materials (silt and clay) either from one location to another through geological (e.g., erosion) or from one soil stratum to another through pedological (eluviation-illuviation)

processes (Esu, 2010). The implications of the distribution trends may include physical impediment to root growth (Lamoureux *et al.*, 2018; Silva *et al.*, 2020) as well as reduction in permeability with increasing soil depth (Reichert *et al.*, 2021).

Table 2: Effects of tree species and soil depth on particle size distribution

Treatment	Particle size Distribution (g kg^{-1})		
	Sand	Silt	Clay
Land use (L):			
Gmelina	676.67b	124.44	198.89a
Teak	678.89b	122.22	198.89a
Eucalyptus	732.22a	113.33	154.44b
Arable field	676.89b	130.33	207.33a
LSD	36.43	22.02	22.31
Soil Depth (cm) (D):			
0-20	748.92a	116.50b	140.42c
20-40	702.33b	114.00b	197.08b
40-60	622.25c	137.25a	232.17a
LSD	31.55	19.07	19.32
Interaction (L x D)	NS	NS	NS

Means with the same letter within the column and factor are not significantly different

Soil chemical properties

The results of the effects of tree species and soil depth on selected soil properties are presented in Table 3. The effect of tree species on soil pH, organic carbon (C), total N and available P was significant except on exchangeable K. Also, significant effects of soil depth on these properties were observed with exception of pH and K. The control had higher ($P < 0.05$) pH value than gmelina, but statistically similar to that what was recorded for teak and eucalyptus. Also, no significant difference soil pH was among gmelina, teak and eucalyptus. This result indicated that the control was neutral, while other land uses were slightly acid in reaction. All pH values are within a favourable range for optimum availability of plant nutrients (Brady and Weil, 2002). The similarity of pH values in all the

layers could be linked similar parent material sources which weathered to produce the soils. All the tree species showed a significantly higher ($P < 0.05$) amount of soil organic C content than the control. It was highest under eucalyptus and lowest under the control, with eucalyptus and teak indicating no significant difference between them, so also for teak and gmelina. Despite these significant differences, organic C content in the soil were rated low in all land use type. Notwithstanding, among the tree species, highest organic C content was recorded under eucalyptus. Report has shown that eucalyptus possess the potential of building large amounts of biomass than any other tree species (Rwibasira *et al.*, 2021) and this could probably be the explanation for having that much of organic C accumulation in the soil. Meanwhile, the lowest organic C

content in arable field could be explained in terms of the long-term tillage practices, high rate of mineralization, removal of crop residue, and lack of application of organic amendments by farmers (Khan *et al.*, 2019). In terms of soil depth, both 0-20 and 20-40 cm were

significantly ($P < 0.05$) higher in organic C content than 40-60 cm. This trend agrees with the findings of Gurebiyaw *et al.* (2019), who reported that dark colours are typical of topmost horizons, being the zone of biomass accumulation and decomposition.

Table 3: Effects of tree species and soil depth on selected soil chemical properties

Treatment	pH	Organic C (g kg ⁻¹)	Total N	Available P (mg kg ⁻¹)	Exch. K (cmol kg ⁻¹)
Land use (L)					
Gmelina	6.42b	2.67b	1.04a	10.89a	0.10
Teak	6.55ab	2.94ab	0.96a	10.78a	0.09
Eucalyptus	6.51ab	3.15a	0.31b	10.78a	0.07
Arable field	6.67a	1.45c	0.31b	5.22b	0.14
LSD	0.21	0.34	0.23	1.03	0.07
Soil Depth (D)					
0-20 cm	6.57	2.65a	0.81a	10.00a	0.08
20-40	6.50	2.66a	0.61b	9.33ab	0.09
40-60	6.54	2.36b	0.55b	8.92b	0.08
LSD	0.18	0.29	0.20	0.89	0.06
Interaction (L x D)	NS	NS	NS	NS	NS

Means with the same letter within the column and factor are not significantly different

Both gmelina and teak showed significantly higher ($P < 0.05$) total N content in the soil than the eucalyptus and the control. Fertility ranking placed the soils under the control (arable field), eucalyptus and teak as very low in N content, while the soil under the gmelina plantation as low. Reasons for low N content all through could be linked to low organic matter content in all land use type, in addition to cropping pattern as well as low use of N-rich fertilizers in arable field by the farmers. Nitrogen is not native to soil and has strong correlation with soil organic matter (Bhunia *et al.*, 2018). According to Pribly (2010), organic matter has been the major source of soil N in tropical soils, accounting to about 95%. In terms of soil depth, the surface layer, 0-20 cm had significantly higher ($P < 0.05$) total N than subsurface layers, 20-40 and 40-60 cm, which

both showed no significant difference between them.

All tree species impacted significantly higher ($P < 0.05$) amount of available P in the soil than the control, but among the tree species, no significant difference was observed. Available P in the soil was deficient under the control and moderate in other land use types. Since the soil pH was found favourable, low to moderate available P status in the soil could be that the soils were developed from phosphorus-deficient parent materials (Mwendwa *et al.*, 2022). The surface layer (0-20 cm) indicated higher ($P < 0.05$) content of available P than both 20-40 cm subsurface, but statistically similar with 20-40 cm. Both 20-40 cm and 40-60 cm depths were not statistically different. There was no interaction between the tree species and soil depths.

The effect of tree species and soil depth on potassium (K) content was not significantly different. However, in terms of fertility ranking, K was low in the soil irrespective of land use type. This could be as a result of higher requirement of potassium by all the tree species which probably matched what is returned to the soil through decomposition and mineralization of litter falls.

Correlation among the Soil Properties

The results showing relationships among the parameters measured are shown in Table 4. Inverse and significant ($P < 0.01$) correlation were observed between sand silt ($r = -0.66$); sand and clay ($r = -0.76$). The inverse relationships could be attributed to the sorting of finer materials (silt and clay) either through the processes involving erosion (from the surface layer) or eluviation and illuviation (down the soil profile) leaving behind a more coarse sand fraction (Akinbola *et al.*, 2009). Clay also showed a similar and significant

($P < 0.05$) correlation with organic C ($r = -0.37$). It is an unusual relationship as clay is known to stabilize organic C in soil. However, this inverse relationship could be attributed to (1) the proportion of organic C relative to total soil mass, (2) soil erosion which removes organic matter concentrated in the topsoil, leading to decline in organic C on one hand or downward migration as earlier explained.

Organic C had positive and significant correlation with total N ($r = 0.36$; $P < 0.05$) and available P ($r = 0.85$; $P < 0.01$) and negative correlation with K ($r = -0.43$; $P < 0.01$). Total N showed significant positive correlation with available P ($r = 0.43$; $P < 0.01$). These results further confirmed strong relationships between organic matter and N as well as P (Pribly, 2010; Bhunia *et al.*, 2018). Inverse correlation between organic C and K implies degrees in the latter despite abundance of the former. The condition likely signalled nutrient imbalance which can affect crop growth and productivity (Brady and Weil, 2002).

Table 4: Correlation matrix showing relationship among the soil parameters

	Sand	Silt	Clay	pH	Organic C	Total N	Avail. P	K
Sand	1							
Silt	-0.66**	1						
Clay	-0.76**	0.20	1					
pH	-0.01	0.04	0.05	1				
Organic C	0.30	-0.21	-0.37*	-0.18	1			
Total N	-0.05	0.05	-0.03	-0.17	0.36*	1		
Avail. P	0.19	-0.16	-0.23	-0.29	0.85**	0.43**	1	
K	-0.28	0.09	0.30	0.22	-0.43**	-0.27	-0.25	1

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed).

Conclusion

The study had established that planting of eucalyptus on degraded sandy soils did not have significant improvement on soil texture and aggregation (structure). Poor canopy architecture of eucalyptus limited its protection on soil against the impact of rain drops and erosion. Also, based on the assessed indices,

all the three tree species assessed were superior over the arable field in terms of improvement in soil organic C, total N and available P content, all linked to their litter fall which enriched the soil with organic matter nutrients. However, teak was found to be the most promising species for use in protecting and revitalizing soil health in the study area. The

study also noted a potential soil acidity threat under gmelina plantation which could not be justified during the present investigation.

It is therefore recommended that farmers and Niger State Ministry of Forestry and Environment should avoid mass planting of eucalyptus species on degraded sandy soils. In subsequent afforestation for protection and restoration of soil quality within the study area and by extension to cover the state, priority in tree species selection should be in the order of teak, gmelina and eucalyptus. Further investigation on gmelina against its potentials to cause soil acidity is recommended.

References

- Adeboye, M.K.A., Bala, A., Osunde, A.O., Uzoma, A.O., Odofin, A.J. & Lawal, B.A. (2011). Assessment of soil quality using soil organic carbon and total nitrogen and microbial properties in tropical agroecosystems. *Agricultural Sciences*, 2(1): 34-40.
- Akinbola, G.E., Anozie, H.I. & Obi, J.C. (2009). Classification and characterization of some pedons on basement complex in the forest environment of south-western Nigeria. *Nigerian Journal of Soil Science*, 19(1): 109-117.
- Akinde, B.P., Olakayode, A.O., Oyedele, D.J. & Tijani, F.O. (2020). Selected physical and chemical properties of soil under different agricultural land-use types in Ile-Ife, Nigeria. *Heliyon*, 6 (2020) e05090. <https://doi.org/10.1016/j.heliyon.2020.e05090>
- Amsalu, A. (2019). Effect of Eucalyptus Plantations on Soil Properties: The Case of Entoto Area, Northern Addis Ababa, Ethiopia. *Journal of Environment and Earth Science*, 9(6): 49-62.
- Augusto, L., De Schrijver, A., Vesterdal, L., Smolander, A., Prescott, C. & Ranger, J. (2015). Influences of evergreen gymnosperm and deciduous angiosperm tree species on the functioning of temperate and boreal forests. *Biological Reviews*, 90, 444–466.
- Bhunja, G.S., Shit, P.K. and Chattopadhyay, R. (2018). Assessment of spatial variability of soil properties using geostatistical approach of lateritic soil (West Bengal, India). *Annals of Agrarian Science*, 16: 436-443.
- Binkley, D. & Giardina, C.P. (1998). Why do tree species affect soils? The warp and woof of tree-soil interactions. In *Plant-Induced soil Changes: Processes and Feedbacks*; Van Breemen, N., Ed.; Springer: Dordrecht, The Netherlands, pp. 89–106.
- Brady, N.C. and Weil, R. (2002). *The Nature and Properties of Soils*. 13th edition. Singapore, Pearson Education. 976pp.
- Chude, V.O., Olayiwola, S.O., Osho, A.O. & Daudu, C.K. (2011). *Fertilizer use and Management Practices for Crops in Nigeria*. Fourth edition. Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. 215pp.
- Dawud, S. M., Raulund-Rasmussen, K., Ratcliffé, S., Domisch, T., Finér, L., Joly, F. X., Hättenschwiler, S. & Vesterdal, L. (2017). Tree species functional group is a more important driver of soil properties than tree species diversity across major European forest types. *Functional Ecology*, 31, 1153–1162.
- De Vries, W., Reinds, G. J., & Vel, E. (2003). Intensive monitoring of forest ecosystems in Europe 2: Atmospheric deposition and its impacts on soil

- solution chemistry. *For. Ecol. Manage.* 174, 97–115.
- Egwunatum, A.E., Ureigho, U.N. & Dolor, D.E. (2015). Effects of *Gmelina arborea* and *Tectona grandis* vegetative cover on the watershed soil characteristics of Iyada River Forest Reserve in Ogwashi-Uku, Delta State. *Journal of Agriculture & Food Environment*, 2(1&2):161-168.
- Esu, I. E. (2010). Soil Characterization, Classification and Survey. HEBN Publishers Plc, Ibadan, Nigeria, 232pp.
- Gurebiyaw, K., Gelanew, A. & Yigzaw, M. (2019). Soil Physical Properties Enhancement via Native Tree Species in Northern Ethiopia. *Journal of Advances in Agriculture*, 10:1680-1691.
- Hu, M., Wang, Y., Li, H., Hu, L., Liu, Q., Zhou, F., Yang, A., Faxin Yu, F. & Ouyang, X. (2024). The Impacts of Tree Species on Soil Properties in Afforested Areas: A Case Study in Central Subtropical China. *Forest*, 15, 895.
<https://doi.org/10.3390/f15060895>
- IITA (2015). Selected Methods for Soil and Plant Analysis. Manual Series No. 3, International Institute for Tropical Agriculture, Ibadan, Nigeria. 126pp.
- Khan, M.Z., Islam, M.A., Amin, M.S. and Bhuiyan, M.M.R. (2019). Spatial variability and geostatistical analysis of selected soil, *Bangladesh Journal of Scientific and Industrial Research*. 54: 55–66.
- Kooch, Y., Samadzadeh, B. & Hosseini, S.M. (2017). The effects of broad-leaved tree species on litter quality and soil properties in a plain forest stand. *Catena*, 150, 223–229.
- Lamoureux, S.C., Poot, P. & Veneklaas, E.J. (2018). Shallow soils negatively affect water relations and photosynthesis in two semi-arid *Eucalyptus* species. *Environmental and Experimental Botany*, 155, 239–250.
- Lawal, B.A., Tsado, P.A., Eze, P.C., Idefoh, K.K., Zaki, A.A. and Kolawole, S. (2014). Effect of slope positions on some properties of soils under a *Tectona grandis* plantation in Minna, southern Guinea savanna of Nigeria. *International Journal of Research in Agriculture and Forestry*, 1(2): 37-43.
- Minh, V.Q., Vu, P.T., Du, T.T., Khoa, L.V. & Tinh, T.K. (2023). Soil color as indicator for fruit garden soil assessment and recommendation. *AgricEngInt: CIGR Journal*, 25(2): 34-44.
- Mishra, A., Sharma, S.D. & Khan, G.H. (2003). Improvement in physical and chemical properties of sodic soil by 3-, 6- and 9-years old plantation of *Eucalyptus tereticornis* bio rejuvenation of sodic soil. *Forest Ecology and Management*, 184, 115–124.
- Mwendwa, S.M., Mbuvi, J.P., Kironchi, G. and Gachene, C.K.K. (2022). Assessing spatial variability of selected soil properties in Upper Kabete Campus coffee farm, University of Nairobi, Kenya. *Heliyon*, 8 (2022) e10190.
<https://doi.org/10.1016/j.heliyon.2022.e10190>
- Niyompuhwe, O., Charbel Maklouf Jabiro, C. M. & Mugunga, C. P. (2023). Effects of *Eucalyptus* species on soil physicochemical properties in Ruhande Arboretum, Rwanda. *Reforesta*, 16: 43-54.
- Ojanuga, A.G. (2006). Agroecological Zones of Nigeria Manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. 124pp.

- Ota, H.O., Aja, D., Okolo, C.C., Oranu, C.O. & Nwite, J.N. (2018). Influence of tree plantation *Gmelina arborea* and *Gliricidia sepium* on soil physico-chemical properties in Abakaliki, Southeast, Nigeria. *Acta Chemica Malaysia (ACMY)*, 2 (2), 23-28. DOI: <http://doi.org/10.26480/acmy.02.2018.23.28>
- Pribyl, D.W. (2010). A critical review of the conventional SOC to SOM conversion factor. *Geoderma*, 156: 75-83.
- Reichert, J.M., Prevedello, J., Gubiani, P.I., Vogelmann, E.S., Reinert, D.J., Consensa, C.O.B., Soares, J.C.W. & Raghavan, J.C.W. (2021). *Eucalyptus* tree stockings effect on water balance and use efficiency in subtropical sandy soil. *Forest Ecology and Management*, 497, 119473 <https://doi.org/10.1016/j.foreco.2021.119473>
- Rwibasira, P., Naramabye, F.X., Nsabimana, D. & Carnol, M. (2021). Long-term effects of forest plantation species on chemical soil properties in southern Rwanda. *Soil System*, 5(59). <https://doi.org/10.3390/soilsystems5040059>
- SAS Institute (2015). *SAS User's Guide*. SAS Institute, Cary., NC, USA.
- Silva, V.E., Nogueira, T.A.R., Abreu-Junior, C.H., He, Z., Buzetti, S., Laclau, J.P., Teixeira Filho, M.C.M., Grilli, E., Murgia, I. & Capra, G.F. (2020). Influences of edaphoclimatic conditions on deep rooting and soil water availability in Brazilian *Eucalyptus* plantations. *Forest Ecology and Management*, 455, 117673 <https://doi.org/10.1016/j.foreco.2019.117673>
- Soil Survey Division Staff (2017). *Soil Survey Manual*. Agriculture Handbook No. 18, United States Department of Agriculture (USDA), 603pp.
- Yimam, A., Mekuriaw, A., Assefa, D. & Bewket, W. (2024). Effect of *Eucalyptus globulus* Plantations on Soil Physicochemical Properties in the Upper Blue Nile, Ethiopia. *Applied and Environmental Soil Science*, 2024, 1-12. <https://doi.org/10.1155/2024/8811109>.