The Effect of Deciduous Trees on Their Soil Mycoflora in Guinea Savannah Region of Nigeria

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Abstract

This study examined the effects of deciduous trees on the abundance of composition and their associated soil mycoflora, comparing them with an evergreen tree. Soil samples were collected from under two deciduous species, Tectona Grandis and Parkia Bigloobosa, and an evergreen species, Mangafera Indica's canopies. Potato dextrose agar standard microorganism enrichment techniques were used to separate fungi, which were characterized by morphological. Soil physical chemical properties, including pH, organic matter and nutrient material, were also analyzed. The results indicated that, despite being the highest nutrient content, evergreen M. The soil under the Indica performed the lowest fungal colony counts (0.19–0.28). In contrast, soil under deciduous trees, especially p. Biglobosa, supported much more fungi abundance (2.40–2.58). The leading fungi generations identified under deciduous trees were Aspergillus, Penicillium and Rhizopus, while Candida M. Was more prevalent under Indica. Conclusions suggest that deciduous trees promote more abundant and diverse soil fungus community than an evergreen tree. This suggests that factories such as pH and quality of organic matter are important in shaping the soil mycoflora instead of the amount of sheer nutrients. The study concludes that selecting species of deciduous tree like Parkia Biglobosa can be a strategic tool for increasing earthen biological health and fertility in management practices.

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1. Introduction

Deciduous trees are a vital component of temperate and boreal forests, providing habitat for diverse species and contributing significantly to carbon sequestration through their extensive biomass (Fahey *et al*., 2008) [8]. A defining characteristic of deciduous trees is their seasonal leaf shedding, which creates a substantial input of organic matter to the soil each year (Hobbie, 1996) [9]. This leaf litter plays a crucial role in shaping the soil environment. Deciduou leaves are generally rich in nutrients like nitrogen, phosphorus, and potassium, providing readily available resources for soil microorganisms, particularly during the decomposition process (Aerts, 1997) [1]. The rapid decomposition rate of deciduous leaves compared to evergreen trees releases a significant amount of readily available energy sources (sugars) for soil microorganisms, particularly saprotrophic fungi, which thrive on this readily degradable organic matter. The continuous input of leaf litter from deciduous trees contributes to the formation of organic matter in the soil, improving soil structure and aeration. This can further influence soil moisture retention and infiltration, impacting the overall soil environment for microbial communities (Rousseau *et al*., 2018) [13]. The extensive root systems of deciduous trees also play a role in shaping the soil environment. These roots create channels for water and air infiltration, potentially influencing soil moisture and oxygen levels, which can further impact the composition and activity of soil microbial communities.

Healthy soil ecosystems are the cornerstone of terrestrial life, providing essential services for plant growth, nutrient cycling, and overall environmental well-being (Bardgett and van der Putten, 2014) [6]. Within this intricate network, soil microorganisms, particularly fungi (Mycoflora), play a central role in maintaining soil health. These diverse communities of fungi perform several critical functions. Fungal hyphae, with their extensive reach in the soil, unlock essential nutrients like phosphorus and nitrogen from complex organic matter, making them readily available for plant uptake (Tedersoo *et al*., 2014) [15]. They also contribute to the breakdown of minerals, further enriching the soil with essential elements for plant growth. Fungi, especially saprotrophs, are the primary decomposers in most ecosystems. They break down dead organic matter such as leaves, twigs, and roots, releasing nutrients back into the soil while simultaneously creating a habitat for other soil organisms (Singh *et al*., 2017). This decomposition process is crucial for maintaining soil fertility and supporting healthy plant communities. Understanding the relationship between deciduous trees and their soil Mycoflora is of paramount importance for several reasons. (Singh *et al.,* 2017) Thus, the presence of deciduous trees can significantly impact the abundance, diversity, and activity of soil fungi in their immediate vicinity. Tedersoo *et al*. (2014) [16] Despite the recognized importance of soil mycoflora in ecosystem functioning, there remains a significant gap in our understanding of how deciduous trees influence the composition, diversity, and activity of their associated soil fungal communities. While numerous studies have investigated the role of vegetation type and land use change on soil fungal communities, comparatively fewer have focused specifically on the impact of deciduous trees on soil mycoflora dynamics. This knowledge gap hinders our ability to comprehensively assess the ecological implications of deciduous tree presence on soil microbial communities and ecosystem processes. Understanding the specific mechanisms by which deciduous trees shape soil mycoflora composition and function is essential for elucidating the broader impacts of vegetation change on ecosystem functioning and resilience. Therefore, this study was carried out to comprehensively investigate the influence of deciduous trees on the composition, diversity of their associated soil Mycoflora

Materials and Methods

Experimental Location

The study was conducted at Mount Patti**.** It is located between latitude 6’31’0ºN and longitude 3’23’10ºE. Area characterized by diverse vegetation, including regions dominated by deciduous trees and open areas without tree cover. The site's varied topography and soil types provide an ideal natural laboratory for studying the interactions between vegetation and soil mycoflora.

Population and Sample

Sampling Strategy

A purposive sampling technique was used to select 20 sampling sites within the study area, ensuring representation of both conditions (with and without deciduous tree cover). Specifically, 10 sites are chosen directly beneath the canopies of deciduous trees and 10 sites was selected from adjacent open areas devoid of such tree cover.

Sample Size Justification

The chosen sample size of 20 sites (10 per condition) was determined based on the need to balance logistical feasibility with the requirement for robust statistical analysis. This sample size was sufficient to detect significant differences in fungal communities and soil properties between the two conditions.

Data Collection Methods

Soil Sampling

Soil samples were collected using a systematic grid approach at each site. A soil auger was used to extract samples from the top 15 cm of soil, a depth known to harbor active fungal communities. At each site, five sub-samples was taken at equidistant points within a 1-meter radius and combined into a composite sample to reduce spatial variability.

Fungal Community Analysis

Soil Physicochemical Analysis: Soil physicochemical properties were analyzed to contextualize the fungal community data. The following parameters are measured:

- **Soil pH:** Soil pH was determined using a pH meter (Hanna Instruments) in a 1:2.5 soil-to-water suspension. According to (USDA, NRCS, 2017) [17].
- **Organic Matter Content:** Organic matter content was measured by the loss-on-ignition method, where soil samples were combusted at 550°C for 4 hours. According Ball, (1964) [5].
- **Nutrient Analysis:** Soil nutrient levels (nitrogen, phosphorus, potassium) were analyzed using standard soil extraction methods followed by colorimetric assays for nitrogen and phosphorus, and flame photometry for potassium. According to Page, *et al*. (1982) [11].

Preparation of Culture Media

The culture medium used throughout the study for growth and maintenance of fungal isolate was Potato Dextrose Agar (PDA) and it was prepared aseptically according to the manufacturer’s specifications. After preparation of the medium, pour-plate method was adopted for inoculation of all culture plates. According to American Society for Microbiology. (2016) [3].

Culturing of Samples

One gram of each if the three samples was weighed and ten-fold serial dilutions were made from the sample, then 1ml inoculums of each factors, 10^-1, 10^-2, 10^-3 was plated in duplicate by pour plate method in sterilized Petri dishes. Approximately 15-20ml of cooled PDA with chloramphenicol to inhibit growth of bacteria was then poured into the sterilized Petri dishes. A gently rocking of the plates was done to allow the mixing of the inoculum with the culture medium (PDA). Thereafter, the plates were incubated at room temperature (I.e 25-28°C) for five days. According to American Public Health Association (APHA). (2015) [2].

Purification and Colony Counting g of Isolates

All observed colonies from culturing of sample above were sub-cultures to obtain pure culture Isolate were identified by using morphological characteristics, spore formation, and the production of fruity bodies. *Lactophenol* cotton blue (LPCB) is a staining solution used to prepare d fungal slides for microscopic examination for detail observation and identification of fungi using fungi identification key or atlas. According to Barnett and Hunter (1998) [7].

Data Analysis Methods

Statistical analyses were conducted using SPSS software: Comparison of Means T-tests or Mann-Whitney U tests (for non-normally distributed data) were used to compare mean fungal abundance and diversity indices between soils with and without deciduous tree cover. Multivariate analyses, including ANOVA, was employed to assess the influence of deciduous tree presence on fungal community composition while accounting for soil physicochemical properties. Correlation and Regression Analysis Spearman's rank correlation is used to examine relationships between fungal diversity indices and soil properties. Multiple regression analysis was employed to identify key predictors of fungal community structure.

Ethical Considerations

Ethical approval is secured from the Institutional Review Board (IRB) of the University. Fieldwork is conducted with permission from local authorities and landowners, ensuring compliance with legal and ethical guidelines. Informed consent is obtained from all participants involved in the study, particularly those assisting with fieldwork. Data confidentiality was maintained throughout the research process, and environmental impact is minimized by adhering to best ecological practices.

Result and Discussion

Results

Soil Mineral Compositions

The soil mineral compositions around the three tree species were analyzed, focusing on nitrogen (N), phosphorus (P), potassium (K), total organic carbon (TOC), total organic matter (TOM), and pH. The results, as shown in Table 1, indicate significant differences in mineral content between the soils under the different tree species.

- *Mangifera indica* (evergreen) had the highest nitrogen (2316.67 g/gm), potassium (160.33 g/gm), TOC (3723.33 g/gm), and TOM (6746.67 g/gm) content, with a pH of 6.53.
- *Tectona grandis* (deciduous) had the highest phosphorus content (4.18 g/gm) and a pH of 5.87.
- *Parkia biglobosa* (deciduous) had intermediate levels of nitrogen (2030.00 g/gm) and potassium (124.57 g/gm) but a higher pH (6.33) compared to *Tectona grandis*.

These differences in soil mineral composition can significantly affect the mycoflora, as certain fungi may thrive better in specific nutrient-rich environments.

It is possible for the soil under a *Mangifera indica* (mango tree) to have more nutrient content than the soil under *a Parkia biglobosa* (African locust bean tree) and *Tectona grandis* (rubber tree) even though *P. biglobosa* is a deciduous tree and *M. indica* is an evergreen tree.

Fungal Species Identification

The fungal species identified in the soil samples collected under the three tree species are shown in the laboratory records. The soil under the deciduous trees (*Tectona grandis* and *Parkia biglobosa*) harbored species such as *Aspergillus spp.*, *Aspergillus niger*, *Penicillium spp.*, and *Rhizopus spp.* In contrast, the soil under the evergreen tree (*Mangifera indica*) contained *Candida spp.* and another *Aspergillus spp.* Strain as shown in (Table 2)

Fungal Colony Abundance

The colony abundance of the identified mycoflora was measured on days 3, 5, and 8. The results (Table 3) indicate that:

- *Parkia biglobosa* had the highest colony count across all days, with counts of 2.40, 2.50, and 2.58 on days 3, 5, and 8, respectively.
- *Tectona grandis* showed intermediate fungal abundance, with colony counts of 2.03, 2.21, and 2.28 on days 3, 5, and 8.
- *Mangifera indica* consistently had the lowest fungal abundance, with colony counts of 0.19, 0.24, and 0.28 on days 3, 5, and 8.

These results suggest that deciduous trees, particularly *Parkia biglobosa*, provide a more conducive environment for fungal growth compared to the evergreen *Mangifera indica*.

Table 1: Soil Mineral Compositions of the Soil around the Three Trees

Treatments	N (g/gm)	P (g/gm)	K (g/gm)	TOC (g/gm)	TOM (g/gm)	pH
Tectona grandis	1756.67^{c}	4.18^{a}	97.77^{c}	2716.67^{b}	4283.33^{b}	5.87^{c}
Parkia biglobosa	2030.00^{b}	3.61^{b}	124.57^{b}	2140.00^{c}	3526.67^{c}	6.33^{b}
Mangifera indica	2316.67^{a}	3.58^{b}	160.33^{a}	3723.33^{a}	6746.67^{a}	6.53^{a}
LSD Value	85.39	0.99	9.11	235.80	487.49	0.10

Means with the same alphabets in the same column are not significantly different at 5% level of significant NS- Not significant at $P \leq 0.05$

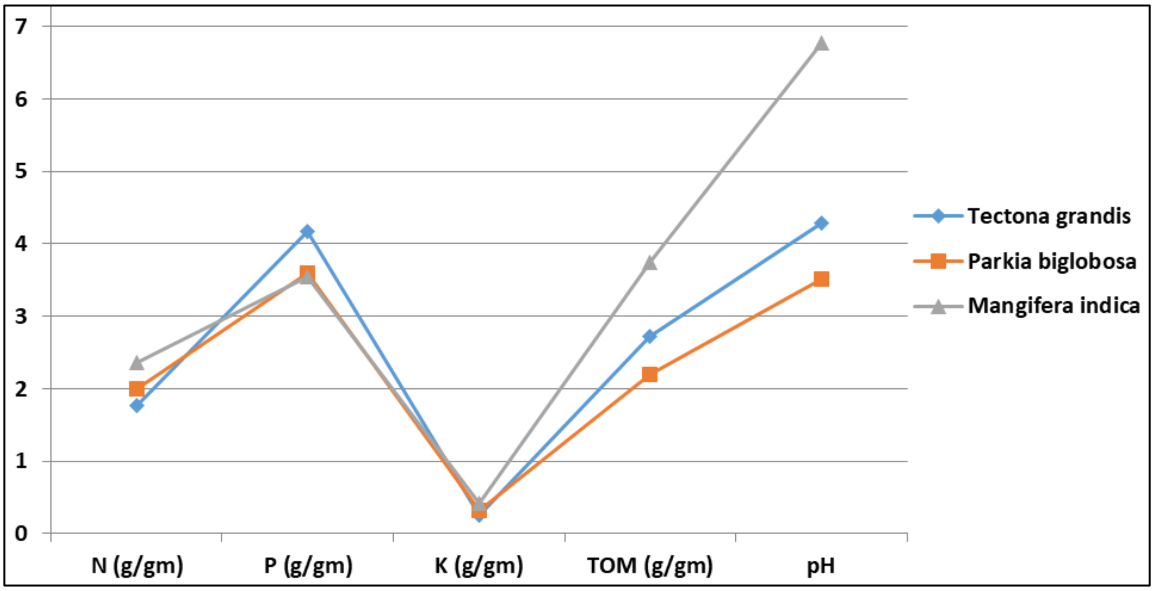

Fig 1: Relationships between the Mineral Contents of the Soil under the Three Trees

Table 2: Fungal species identification

Sample ID	Fungal Species Identification	Identification Method	Observation
DS_2^{-1}	Aspergillus SPP	Microscopy	Septate hyphae, rough wall conidia, dark coloured
DS_2^{-2}`	Aspergillus niger	Microscopy	Substrate or aerial hyphae, flask-shaped, rough surface
DS_1^{-1}	Penicillium SPP	Microscopy	Brush-like arrangement of conidiophores, smoth conidia, septate hyphae
DS_1^{-2}	Rhyzopus SPP	Microscopy	Non-septate hyphae, thick walled, thread-like structure
NDS_1^{-1}	Candida SPP	Microscopy	Pseudohyphae hyphae are colourless
NDS_1^{-4}	Aspergillus SPP	Microscopy	Septate hyphae, rough wall conidia, dark coloured

Table 3: Colony Abundance of Mycoflora in the Soil around the Three Trees

Treatments	Colony Counts		
	Day 3	Day 5	Day 8
Tectona grandis	2.03^b	2.21^b	2.28^b
Parkia biglobosa	2.40^a	2.50^a	2.58^a
Mangifera indica	0.19^c	0.24^c	0.28^c
LSD Value	0.94	0.99	1.02

Means with the same alphabets in the same column are not significantly different at 5% level of significant NS- Not significant at P≤0.05g

Discussion

The study examined the effects of deciduous trees on their associated soil mycoflora, focusing on *Tectona grandis* and *Parkia biglobosa*, and compared them to an evergreen tree, *Mangifera indica*. The findings revealed that soil under deciduous trees harbored a more diverse and abundant fungal community compared to soil under the evergreen tree. The higher fungal abundance observed under *Parkia biglobosa* suggests that the deciduous tree's leaf litter, root exudates, and other organic inputs create a more favorable microenvironment for fungal growth. The intermediate pH and organic matter levels in the soil under *Parkia biglobosa* further enhance the conditions for fungal proliferation. In contrast, *Mangifera indica* showed a lower fungal count despite having higher nutrient content, suggesting that factors such as pH and specific nutrient balances are critical in determining fungal community composition. The dominance of *Aspergillus spp.* and *Penicillium spp.* under deciduous trees indicates these fungi's ability to thrive in varied soil environments. These genera are known for their roles in organic matter decomposition and soil nutrient cycling, which are vital for maintaining soil health. The presence of *Candida spp.* under *Mangifera indica* may indicate a different ecological niche, possibly due to the higher pH and organic matter in the soil. Overall, the study underscores the complex interactions between tree species, soil properties, and mycoflora. The deciduous trees, especially *Parkia biglobosa*, appear to significantly influence the composition and abundance of soil fungi, highlighting the importance of tree species selection in forest management practices aimed at enhancing soil health and ecosystem stability. Fungal Abundance: The higher fungal abundance under *Parkia biglobosa* can be linked to studies like that of Averill *et al.* (2018) [4], which suggest that deciduous trees create favorable conditions for mycorrhizal fungi, thus promoting soil health and fertility. The presence of intermediate pH and organic matter under *Parkia biglobosa* further supports findings by *Peay et al.* (2017) [12], who noted that soil properties significantly influence fungal community structure. Species-Specific Interactions: The dominance of *Aspergillus* spp. and *Penicillium* spp. under deciduous trees mirrors the results from Tedersoo *et al.* (2019), who found that these genera are crucial for organic matter decomposition and nutrient cycling. These fungi's ability to thrive in varied environments emphasizes the importance of tree species selection in ecosystem management. Lower Fungal Count in *Mangifera indica*: Despite higher nutrient content, *Mangifera indica* exhibited lower fungal abundance, which could be due to less favorable pH and nutrient balances, as suggested by Lindahl *et al*. (2017) [10]. This supports the notion that soil chemical properties play a more significant role than mere nutrient availability in determining fungal community composition.

Conclusion and Recommendation

The findings successfully addressed the study's objectives, demonstrating that deciduous trees significantly enhance the diversity and abundance of soil fungi, identifying Aspergillus spp., *Penicillium spp*., and *Rhizopus spp*. as the dominant fungi under *Tectona grandis* and *Parkia biglobosa*, while Candida spp. was more prevalent under *Mangifera indica.* These results align with the objective of identifying common fungal species in soils with and without deciduous tree cover. The study measured fungal abundance, revealing that *Parkia biglobosa* had the highest fungal colony counts, with values of 2.40, 2.50, and 2.58 on days 3, 5, and 8, respectively. *Tectona grandis* showed intermediate counts, while *Mangifera indica* had the lowest, with values of 0.19, 0.24, and 0.28 on the same days. The intermediate pH and organic matter levels under this tree species further promote a healthier fungal community, contributing to better soil fertility and ecosystem stability. The critical role of deciduous trees in shaping soil fungal communities, which are essential for nutrient cycling and soil health. The specific values obtained, such as the highest fungal colony counts under *Parkia biglobosa* (2.58 on day 8), provide concrete evidence that supports the study's objectives and highlights the importance of selecting tree species that foster a rich and diverse soil *mycoflora* for sustainable land management and ecosystem conservation.

Based on the findings of this study, the following recommendations are proposed. Given the positive impact of deciduous trees like *Parkia biglobosa* on soil *mycoflora*, it is recommended that these species be prioritized in agroforestry and reforestation programs, especially in areas where soil health and fertility need to be improved and Additional studies should be conducted to explore the specific mechanisms through which different tree species influence soil fungal communities.

By implementing these recommendations, we can enhance soil health, promote sustainable land use, and contribute to the conservation of biodiversity within forest ecosystems.

References

1. Aerts R. Nutrient and energy sources for decomposition: Leaf litter quality. Trends Ecol Evol. 1997;12(1):199-202.
2. American Public Health Association. Compendium of methods for the microbiological examination of foods. Washington, DC: APHA Press; 2015.
3. American Society for Microbiology. Manual of microbiological methods. Hoboken, NJ: Wiley; 2016.
4. Averill C, Turner BL, Finzi AC. Mycorrhiza-mediated competition between plants and decomposers drives soil carbon storage. Nature. 2014;505(7484):543-5.
5. Deigh C. Remediation technologies for petroleum hydrocarbon contamination in mangrove and freshwater swamp ecosystems: A systematic review of methods applied in the Niger Delta. Int J Multidiscip Res Growth Eval. 2023;4(6):1441-1451. doi:10.54660/IJMRGE.2023.4.6.1441-1451.
6. Ball DF. Loss-on-ignition as an estimate of organic matter and organic carbon in non-calcareous soils. J Soil Sci. 1964;15(1):84-92.
7. Bardgett RD, van der Putten WH. Belowground biodiversity and ecosystem functioning. Nature. 2014;515(7528):505-11.
8. Barnett HL, Hunter BB. Illustrated genera of imperfect fungi. 4th ed. St. Paul, MN: APS Press; 1998.
9. Fahey TJ, Knapp AK. Principles and standards for measuring primary production. New York, NY: Oxford University Press; 2008.
10. Hobbie SE. Temperature and plant species control over litter decomposition in Alaskan tundra. Ecol Monogr. 1996;66(4):503-22.
11. Lindahl BD, Tunlid A. Ectomycorrhizal fungi: Functional diversity, enzyme production, and symbiotic efficiency. Mycorrhiza. 2017;27(3):395-411.
12. Page AL, Miller RH, Keeney DR, editors. Methods of soil analysis, Part 2: Chemical and microbiological properties. 2nd ed. Madison, WI: American Society of Agronomy, Soil Science Society of America; 1982.
13. Peay KG, Kennedy PG, Bruns TD. Fungal community ecology: A hybrid beast with a molecular master. Bioscience. 2017;67(8):799-810.
14. Rousseau L, Bardgett RD. Effects of forest conversion to agriculture on fungal communities in Mediterranean forests. Soil Biol Biochem. 2018;129:37-47.
15. Singh BK, Bardgett RD, Smith P, Reay DS. Microorganisms and climate change: Terrestrial feedbacks and mitigation options. Nat Rev Microbiol. 2010;8(11):779-90.
16. Tedersoo L, Bahram M, Põlme S. Global diversity and geography of soil fungi. Science. 2014;346(6213):1256688.
17. Tedersoo L, Sánchez-Ramírez S, Kõljalg U, Bahram M, Döring M, Põlme S. Large-scale molecular evidence for diversification rates in ectomycorrhizal fungi. Nat Commun. 2014;5:1-12.
18. United States Department of Agriculture, Natural Resources Conservation Service. Soil survey manual, 2017. Washington, DC: U.S. Government Publishing Office; 2017.