

GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

Abstract

This study was carried out at Kiyawa community and aimed at determining tree growth attributes, identifying fungi, bacteria and determining the microbial load in the Neem and Eucalyptus shelterbelt. Data were collected from four temporary sample plots of 30 x 30m each laid at interval of 100 m along a line transect of 500m in length. Also, 1 × 1m subplot was laid within the 30 x 30 m plot and used for soil sample collection. Dbh and total height of all trees were measured using a measuring tape and spigeal relascope while volume and Basal area were calculated using appropriate formula. Potato Dextrose Agar and Nutrient Agar media were used for the isolation of fungi and bacteria. The collected data was analysed using descriptive statistics and t-test. The Neem shelterbelts had the highest Dbh, Basal area, Height, and volume of 82.25cm±1.23, 0.90m²±0.15, 15.90m±0.2, 97.08m³±4.27m³ followed by Eucalyptus shelterbelt which had the lowest value of 62.50±0.93cm, 0.463±3.43m, 3.75±0.03 and 3.48±2.43m. The findings revealed the presence of three (3) bacteria species in each study site. *Staphylococcus aureus* and *Bacillus cereus* were found in the Eucalyptus shelterbelt, while *Bacillus subtilis* and *E. coli* were found in the neem shelterbelt. However, *Aspergillus flaming* occurred in eucalyptus shelterbelt while *Fusarium oxysporum* was found in Neem shelterbelt. Result showed that mean microbial load of fungi (Eucalyptus = 1.45x 10⁶; Neem = 1.50 x10⁶) was higher than that of bacteria (Eucalyptus = 1.24 x 10⁶; Neem = 1.3 x10⁶). There was significant difference (p≤ 0.05) between the bacterial microbial loads between the two study sites. Thus, the shelterbelt supports growth of neem tree and fungal growth. Therefore, interplanting of tree with arable crops is recommended for improved economic production and enhancement of shelterbelt.

Keywords: Growth characteristics, Neem, Eucalyptus, Kiyawa, Microbial population, Shelterbelts

Authors

Salami K. D

Department of Forestry and Wildlife Management, Federal University Dutse, Nigeria
E-mail: foristsalam@yahoo.com

Lawal A. A.

Forest Ecology and Conservation Unit, Center for Arid Zone Ecology, Federal University Dutse, Jigawa State, Nigeria

I. INTRODUCTION

Forest inventory is the collection of data and forest information for assessment of its resources. An estimate of the value and possible uses of timber is an important part of the broader information required to sustain ecosystems (Dau and Chukwu, 2018). It provides information on the account of the forested area which includes ownership and accessibility, estimates of timber quality and quantities, estimates of growth and drains. Non-timber information may also be included, such as wildlife resources, areas of recreational and touristic interest, soil and land use capabilities on watershed values and among others (Saka *et al.*, 2020; Salami and Akinyele, 2017). Forest biodiversity protection depend on the ability to assess sites, quantify and predict spatial and temporal trends of key species which maintain a natural disturbance regime and limit harmful human activities (Thompson *et al.*, 2009). According to the International Union for Conservation of Nature (IUCN), protected area is an area of land and/or sea dedicated to the protection, maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means (IUCN, 1994).

Forest protected areas help to conserve ecosystems which provide cover, food, raw materials, germplasm, a barrier against disasters, a stable source of resources, goods and services which could have an vital role in assisting species, human being and nations to adapt with climate change (<https://www.fao.org/3/i0670e/i0670e13.htm>). In addition, they assist in conserving indigenous species that are resistant to pests, diseases and pathogens, environmental stresses and nutrient loss, especially in natural forests. They can thus continue to serve as a natural storehouse of genetic material into the future. Soil is a multifaceted and dynamic ecosystem where substantial physical, chemical, and biological processes take place (Jelena *et al.*, 2018). According to Nannipieri *et al.* (2003), the most important biological processes in soil (80-90%) occur due to the reactions of microbial enzyme systems.

Rousk *et al.* (2008), stated that soil chemical and physical characteristics are key factors of soil microbial community structure. The physicochemical properties of soil are mostly related to soil fertility which affects the floristic composition of forests. There is a common connection between the soil microflora and the vegetation of an ecosystem. Microorganism helps in mineralization and decomposition of plant materials to a form that can be absorbable by plants (Pietikainen, 1999). Also, Sigstad *et al.* (2002) recognized bacteria as the most occurring microflora and it is through their metabolic activity that minerals and soil organic matter are transformed in a way that vital nutrients such as N, P, and S are concurrently changed into usable forms for plant and micro-organisms.

Eucalyptus camadulensis tree has extractives that are known to have antitermic repellent activities (Jibo *et al.*, 2021; Geoff, 2007) and discharges compounds which inhibit the germination and growth of plant competitors. Outside their natural ranges, the species is applauded for their valuable economic impacts on poor populations (Luzar, 2007). According to "Merriam Webster" Shelterbelt are barrier of trees and shrubs that provide protection from wind, storm and erosion. A shelterbelt is commonly made up of one or more rows of trees or shrubs planted in such a way to offer shelter from wind and to protect soil against erosion. Shelterbelts are also windbreaks because they are commonly planted in hedge rows around the edges of fields on farms. Shelterbelts play roles in the daily lives of people, specially farmers. Some of the uses are: providing habitat for wildlife, provide woods when the trees

GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

are harvested, windbreaks reduce the cost of heating and cooling and thus save energy (Karen, 2023). The aim of the study is to access the growth variables and microbial population of Katika Shelterbelt, Jigawa State, Nigeria with the view of providing better management and conservation strategies for the shelterbelts.

II. MATERIALS AND METHOD

The Study Area

The Shelterbelts, which are situated in Kiyawa Local Government Area of Jigawa state, Nigeria (Figure 1), were established in 1989 by the former Department of Forestry, Ministry of Environment Kano State. Jigawa and Kano were ruled under the same government. Kiyawa Local Government Area later fall under Dutse Emirate (Salami *et al.*, 2022) and covers an area of about 3 hectares. They are positioned at Latitude 11°45'49"N, 09°36'48"E. The elevation of the site is about 500-600m above the sea level (Maryam *et al.*, 2019). The tree species used in the Shelterbelts are *Azadirachta indica* and *Eucalyptus camaldulensis* (Plate 1 and 2), which are planted in rows (Jigawa Agricultural Rural Development Agency, 2016). The annual mean temperature is about 25°C but the mean monthly value ranges between 21°C (coolest month) # and 31°C (hottest month) (Azare *et al.*, 2019) and also soil form is sandy (Salami and Lawal, 2018; Jibo *et al.*, 2021) while the mean temperature and rainfall are 37.78°C and 552mm respectively (Salami *et al.*, 2022).

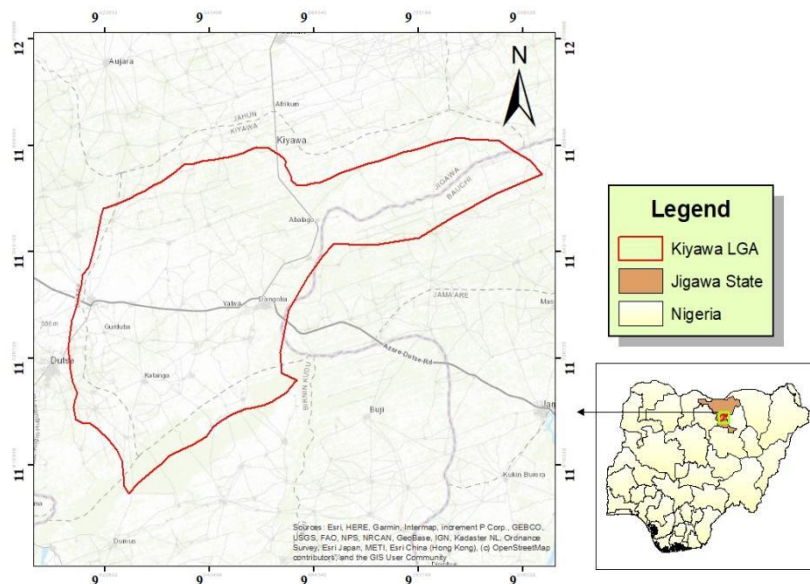


Figure 1: Map of Kiyawa Local Government Area of Jigawa state (insert Map of Nigeria showing the location of Jigawa State).



Plate 1: Shelter belt of *Azadirachta indica* (Neem) (Field survey, 2021)



Plate 2: Shelter belt of *Eucalyptus camaldulensis* (Field survey, 2021)

III. DATA COLLECTION

Sampling Layout and Procedure: Systematic sampling design (systematic line transects) was used in laying out of the plot. A line transects of 500m with four samples of size 30m × 30m was laid in each shelterbelt at 100m interval. Eight sample plots were assessed during experiment for both studies. All woody plants within the sample plots were enumerated while 1m x 1m sample plot was laid within each of the sample plot for soil collection (Aminu, 2021; Salami, 2017)

Tree Enumeration: All Woody tree and shrubs with diameter at breast height (Dbh) of 10 cm and above were counted and measured. Growth variables such as the diameter at the base (Db) and diameter at the breast height (Dbh) were measured using measuring tape in centimetre (cm) while the diameter at the top and the height were assessed using Spiegel Relaskop in centimetres (cm). Basal area and volume were determined using equations 1 and 2.

Soil Collection: Soil samples were collected at 0 - 15cm depth along the diagonal from one point for each of the sample plot with the aid of a soil auger. Soil sample collected was bulked. The soil sample was collected at soil depth of 0-15cm only, because the number of count of bacteria and fungi always decrease with the depth of soil sample (Lawal *et al.*, 2018)

Identification of Micro-Organisms: Fungi structure was studied with the use of microscope by noticing colony structures (Colour and texture) and by staining with lacto phenol cotton blue and observed under compound microscope for the conidia, conidiophores and arrangements of spores (Ameba, 2001). Gram staining was carried out on the growth culture plate to differentiate gram negative organism from gram positive organism. Biochemical test was carried out base on Gram's result in the laboratory of the Department of Microbiology, Federal University Dutse in February, 2021.

Isolation of Micro-Organisms: Potato Dextrose Agar (P.D.A) media was used for the isolation of fungi, the plate was kept at room temperature for 7 days. Dilution was prepared and used for the isolation of Bacteria. One (1g) of soil sample was taken and serial dilution was carried out in distilled water. Nutrient Agar (N.A) medium was used to isolate bacteria sterilized in autoclave for 15 minutes at 121°C. After 2 hours of incubation at 37°C. Streaking plate method was used to get single colonies of the culture (Shanmugam *et al.*, 2013).

Data Analysis: The data collected was analyzed using descriptive statistics such as tables while inferential such as independent T- test was employed to compare fungi, bacterial and microbial population in the study sites.

Basal Area Calculation: The basal area of all trees in the sample plots was calculated using this formula:

$$BA = \frac{\pi D^2}{4} \dots \dots \dots (eqn 1)$$

Where **BA** = Basal area (m²), **D** = Diameter at breast height (cm) and Pie (3.142).

Volume over Bark Estimation: Using smailian's formular

$$V = \frac{h(Db + Dt)}{2} \dots \dots \dots (eqn 2)$$

Where V = Volume over bark (m³), H = stem height (m), Db = Diameter at the base and Dt = Diameter at the top

IV. RESULTS

Presented in Table 1 is the growth variable of Neem and Eucalyptus species in the shelterbelts. The diameter at breast height (DBH) measurements for Neem and Eucalyptus trees in the study site ranged from 0.20 to 1.45 m and 0.18 to 1.07 m, respectively. The mean DBH for Neem was 0.82 meters, while for Eucalyptus, it was 0.63 meters. The standard error for both species was relatively low, 1.23 and 0.93 meters for Neem and Eucalyptus species respectively. Neem trees exhibited a basal area ranging from 0.15 to 1.65 square meters, while Eucalyptus trees ranged from 0.025 to 0.90 square meters. The mean basal area for Neem was 0.90 square meters, whereas for Eucalyptus, it was 0.46 square meters. Eucalyptus trees showed a wider range of basal area values. The standard error for the basal area for Neem was 0.15 and 3.43 meters for Eucalyptus. The heights range from 2.90 to 13.00 meters for the Neem trees, while Eucalyptus trees ranged from 1.20 to 6.30 meters. The mean height for Neem was 15.90 meters, and for Eucalyptus, it was 3.75 meters. The standard error for height measurements were 0.24 and 0.03 meters for Neem and Eucalyptus species respectively. Neem trees showed a volume range of 56.55 to 1885 cubic meters, while Eucalyptus trees ranged from 21.60 to 674.1 cubic meters. The mean volume for Neem was 999.90 cubic meters, whereas for Eucalyptus, it was 365.24 cubic meters. The standard error for volume measurements was relatively low for both species.

Table 1: Growth Variables of Neem and Eucalyptus Species in the Shelterbelts

| Parameters | Study Site | Min | Max | Total | Mean | Stand Error |
|------------------------------|------------|-------|-------|--------|--------|-------------|
| DBH(m) | Neem | 0.20 | 1.45 | 84.42 | 0.82 | 1.23 |
| | Eucalyptus | 0.18 | 1.07 | 65.62 | 0.63 | 0.93 |
| Basal Area (m ²) | Neem | 0.15 | 1.65 | 92.70 | 0.90 | 0.15 |
| | Eucalyptus | 0.025 | 0.90 | 48.56 | 0.46 | 3.43 |
| Height (m) | Neem | 2.90 | 13.00 | 818.85 | 15.90 | 0.24 |
| | Eucalyptus | 1.20 | 6.30 | 393.75 | 3.75 | 0.03 |
| Volume (m ³) | Neem | 56.55 | 1885 | 999.90 | 970.78 | 1.27 |
| | Eucalyptus | 21.60 | 674.1 | 365.24 | 347.85 | 2.43 |

Source: Field survey, (2021)

Table 2 showed the comparative analysis of soil bacterial occurrence in Eucalyptus and Neem Shelterbelts. The table lists several bacterial species, including *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas spp*, *Bacillus subtilis*, and *E. coli*. Each bacterial species was either marked "V" (present) or left empty (absent) in both Eucalyptus and Neem shelterbelts. It was shown that there is a presence of soil bacteria in both Eucalyptus and Neem shelterbelts. The data indicate a similar number of bacterial species (3) occurring in both types of shelterbelts. *Staphylococcus aureus* was found in Eucalyptus shelterbelts but was absent in Neem shelterbelts. *Bacillus cereus* was present in both Eucalyptus and Neem shelterbelts. *Pseudomonas spp* was found in both shelterbelt types. *Bacillus subtilis* was observed in Eucalyptus shelterbelts. *E. coli* was present in both shelterbelt types.

Table 2: Occurrence of Soil bacteria in Eucalyptus and Neem Shelterbelts

| SN | Species | Eucalyptus shelterbelt | Neem shelterbelt |
|--------------|------------------------------|------------------------|------------------|
| 1 | <i>Staphylococcus aureus</i> | V | |
| 2 | <i>Bacillus cereus</i> | V | |
| 3 | <i>Pseudomonas spp</i> | V | V |
| 4 | <i>Bacillus subtilis</i> | | V |
| 5 | <i>E.coli</i> | | V |
| Total | | 3 | 3 |

Note: V= present

Source: Field survey, (2021)

Table 3 highlighted the occurrence of soil fungi in Eucalyptus and Neem shelterbelts. It also lists several fungal species, including *Aspergillus niger*, *Aspergillus flavus*, *Penicillium spp*, and *Fusarium oxysporum*. Each fungal species was either marked "V" (present) or left empty (absent) in both Eucalyptus and Neem shelterbelts. The data indicate that there is a presence of soil fungi in both Eucalyptus and Neem shelterbelts. Similar to the bacterial data (Table 2), the table shows that both types of shelterbelts have an equal number of fungal species (3) occurring. *Aspergillus niger* and *Penicillium spp* were found in both Eucalyptus and Neem shelterbelts. *Aspergillus flavus* was present in Eucalyptus shelterbelts but absent in Neem shelterbelts. *Fusarium oxysporum* was observed in Eucalyptus shelterbelts.

Table 3: Occurrence of Soil Fungi in Eucalyptus and Neem Shelterbelt

| SN | Species | Eucalyptus shelterbelt | Neem shelterbelt |
|--------------|---------------------------|------------------------|------------------|
| 1 | <i>Aspergillus niger</i> | V | V |
| 2 | <i>Aspergillus flavus</i> | V | |
| 3 | <i>Penicillium spp</i> | V | V |
| 4 | <i>Fusarium oxysporun</i> | | V |
| Total | | 3 | 3 |

Note: V= present

Source: Field survey, (2021)

Table 4 provided data on the mean microbial population of soil bacteria in Eucalyptus and Neem shelterbelts based on the field survey conducted. It listed out the bacterial species involved which are *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas spp*, *Bacillus subtilis*, and *E. coli*. The bacterial populations are measured in colony forming units per gram (CFU/g) of soil for both Eucalyptus and Neem shelterbelts. The data show the population of soil bacteria in both Eucalyptus and Neem shelterbelts. Overall, the mean bacterial population in Neem shelterbelts (1.3×10^6 CFU/g) is slightly higher than in Eucalyptus shelterbelts (1.24×10^6 CFU/g). *Staphylococcus aureus* has a population of 1.32×10^6 CFU/g in Eucalyptus shelterbelts, while it is not observed for Neem shelterbelts. *Bacillus cereus* has a population

GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

of 9.2×10^5 CFU/g in Eucalyptus shelterbelts but is not observed for Neem shelterbelts. *Pseudomonas spp* populations are 1.48×10^6 CFU/g in Eucalyptus and 2.18×10^6 CFU/g in Neem shelterbelts. *Bacillus subtilis* is observed only in Eucalyptus shelterbelts. *E. coli* populations are present in both shelterbelt types.

Table 4: Mean microbial population of soil bacteria in Eucalyptus and Neem shelterbelt

| SN | Species | Eucalyptus shelterbelt (CFU/g) | Neem shelterbelt (CFU/g) |
|----|------------------------------|--------------------------------------|-------------------------------------|
| 1 | <i>Staphylococcus aureus</i> | 1.32×10^6 | |
| 2 | <i>Bacillus cereus</i> | 9.2×10^5 | |
| 3 | <i>Pseudomonas spp</i> | 1.48×10^6 | 2.18×10^6 |
| 4 | <i>Bacillus subtilis</i> | | 1.46×10^6 |
| 5 | <i>E.coli</i> | | 1.56×10^6 |
| | Mean | 1.24×10^6 | 1.3×10^6 |

Note: CFU/g is colony forming unit

Source: Field survey, (2021)

The Comparative Analysis of Soil Fungal Populations in Eucalyptus and Neem Shelterbelts is shown in Table 5 below. *Aspergillus niger*, *Aspergillus flavus*, *Penicillium spp*, and *Fusarium oxysporum* were the fungal populations present in the soil. This fungal populations are measured in colony forming units per gram (CFU/g) of soil for both Eucalyptus and INeem shelterbelts. The mean fungal population in Neem shelterbelts (1.50×10^6 CFU/g) is slightly higher than in Eucalyptus shelterbelts (1.45×10^6 CFU/g).

Aspergillus niger has a population of 1.30×10^6 CFU/g in Eucalyptus shelterbelts and 1.88×10^6 CFU/g in Neem shelterbelts. *Aspergillus flavus* has a population of 1.01×10^6 CFU/g in Eucalyptus shelterbelts but is absent in Neem shelterbelts. *Penicillium spp* populations are 2.04×10^6 CFU/g in Eucalyptus and 1.38×10^6 CFU/g in Neem shelterbelts. *Fusarium oxysporum* is reported only in Neem shelterbelts.

Table 5: Mean microbial population of soil fungi in Eucalyptus and Neem shelterbelt

| SN | Species | Eucalyptus shelterbelt (CFU/g) | Neem shelterbelt (CFU/g) |
|----|---------------------------|--------------------------------------|--------------------------------------|
| 1. | <i>Aspergillus niger</i> | 1.30×10^6 | 1.88×10^6 |
| 2 | <i>Aspergillus flavus</i> | 1.01×10^6 | Nil |
| 3 | <i>Penicillium spp</i> | 2.04×10^6 | 1.38×10^6 |
| 4 | <i>Fusarium oxysporun</i> | Nil | 1.23×10^6 |
| | Mean | 1.45×10^6 | 1.50×10^6 |

Note: CFU/g is colony forming unit

Source: Field survey, (2021)

Table 6: Bio- chemical test for shelterbelt A (Eucalyptus)

| Samples | Catalase | Oxidase | Indole | Methyl Red | Vogesprokau | Nitrile Reduction | Coagulase | Citrate | Urease |
|---------|----------|---------|--------|------------|-------------|-------------------|-----------|---------|--------|
| S1 | + | - | - | + | + | + | + | + | + |
| S2 | + | - | - | + | + | + | + | + | + |
| S3 | + | - | - | - | + | - | - | + | - |
| S4 | + | + | - | - | - | + | - | + | - |

Table 7: Biochemical test for shelterbelt B (Neem)

| Samples | Catalase | Oxidase | Indole | Methyl red | Vogesprokau | Nitrile reduction | Coagulase | Citrate | Urease |
|---------|----------|---------|--------|------------|-------------|-------------------|-----------|---------|--------|
| S1 | + | + | - | - | - | + | - | + | - |
| S2 | + | - | - | - | + | - | - | + | - |
| S3 | + | - | - | - | + | - | - | + | - |
| S4 | + | - | + | + | - | + | - | + | - |

V. DISCUSSION

Growth Parameter Indices

The results showed that *A. indica* plots had the highest Dbh, Basal area, total height, and volume of 82.25 ± 1.23 cm, 0.90 ± 0.15 m², 15.90 ± 0.24 m and 97.78 ± 4.27 m³, respectively while the *E. camaldulensis* shelterbelt hotspot which had the lower value of 62.50 ± 0.93 cm, 0.463 ± 3.43 m², 3.75 ± 0.03 m and 3.48 ± 2.43 m³, respectively. However, the results were obtained from two different studies sites. It showed that *A. indica* had higher productivity (volume and basal area) and growth (height, dbh) compared to *E. camaldulensis*. The mean basal area of 0.90 ± 0.15 m² that was obtained from Neem shelterbelt, implies that Neem shelterbelt had high tree density that can be useful for such purposes as wood for furniture, electric poles, fuelwood, charcoal production, etc when properly managed. The *E. camaldulensis* shelterbelt, with basal area of 0.463 ± 3.43 m², will also be useful for the inhabitants of the study area. Thus, in addition to their environmental protection goal (e.g. windbreak) tree species used in shelterbelt can serve other purposes. The result disagrees with the finding of Salami *et al.* (2021), who reported higher mean volume and Basal area (14.13 m³; 339.998 m²) at Warwade plantation than the results of study.

Presence of Fungi and Bacterial

Tables 2 and 3 revealed the presence of soil bacteria and fungi in the study sites. The findings showed the presence of three (3) species of bacteria in the study site. Eucalyptus shelterbelt had *Staphylococcus aureus* and *Bacillus cereus* while *Bacillus subtilis* and *E. coli*

GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND
EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

were presence in Neem shelterbelt. *Pseudomonas spp* were encountered in the shelterbelt with both tree species. This implies that this species can thrive and found the two habitats. Four different species of fungi were found to be present in both sites. Two (2) of the fungi were common to the two shelterbelt while one species found to be only present in each of the sites. The fungi: *Aspergillus Niger* and *Penicillium species* were present in both study sites. However, *Aspergillus flavus* only occurred in Eucalyptus shelterbelt while *Fusarium oxysporum* was only present in Neem shelterbelt.

Relationship between Microbial Populations of the Study Sites

The microbial load of fungi and bacteria were influenced by physical features of the soil of the study sites. This agrees with finding of Ateh *et al.* (2020) who reported that the texture of the soil determine the nature of microbes present. Microbial organism plays importance roles in the decomposition of organic matter, nitrogen fixation and nutrient cycling (Lawal *et al.*, 2018; Ateh *et al.*, 2019). The effects of the soil microbes are influenced by their population classes (Archana *et al.*, 2015). Microbial population in forest soils are determined by both chemical and physical properties of the soil (Seeley, 1981). The results from Tables 4 and 5 showed the relationship between loads of bacteria and fungi found in the study site. The study revealed that five (5) species of bacterial were found which are *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas spp*, *Bacillus subtilis* and *E.coli*. A higher load of *Pseudomonas spp* was recorded in the Neem shelterbelt (2.18×10^6) compared with that of Eucalyptus shelterbelt (1.48×10^6). The mean of Neem hotspot was recorded to be 1.3×10^6 which is higher than Eucalyptus hotspot with value of 1.24×10^6 . This implies that bacterial microbial load is more prominent and active in the neem than Eucalyptus shelterbelt. However, there was no significant difference between the bacterial microbial loads the shelterbelt of the two species ($p \leq 0.05$).

Furthermore, there is similarity in the microbial load of fungi recorded in the two study sites, with overall mean values of 1.45×10^6 and 1.50×10^6 For Eucalyptus and Neem shelterbelt, respectively. *Aspergillus niger* was higher in Neem shelterbelt than in Eucalyptus shelterbelt with respective microbial loads of 1.88×10^6 and 1.3×10^6 while for *Penicillium spp*, the microbial load was higher in Eucalyptus (2.06×10^6) than Neem shelterbelt (1.38×10^6). The weight of the fungi was lower in Eucalyptus shelterbelt due probably to the effect of allele-chemicals which was higher in Eucalyptus than Neem shelterbelt. The results on Tables 4 and 5 revealed that fungi load was higher than bacteria load at both study sites. Some research workers (e.g. Barbour *et al.*, 1987; Zhou *et al.*, 2018) had revealed that the nature of physical properties of the forest soil determines the type of microbes in the soils and their populations. The dominant and structural organization of the sand textural class in the study sites provided a spatially heterogeneous habitat for fungal community because the of smaller size fractions (silt and clay) host higher bacterial community than larger size particle (size). Ateh *et al.* (2019) reported that microbial load of fungi was higher than bacteria with the value of 4.49×10^5 and 3.43×10^5 respectively at the same soil profile level (0-15cm) in Girea soil of Adamawa, which is supported by the results of this study. Our results also agree with that of Nkereuwem *et al.* (2020), who reported that fungi did better than bacteria in adapting to drying rewetting stress across the different soil locations during the drying rewetting cycle. However, Adekunle *et al.* (2005), disagreed with the finding and reported that the amount of bacterial load is higher than that of fungi load in Akure Forest Reserve in

GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

southwestern , Nigeria with the range of (26.10^6 to 360×10^6 MPNG⁻¹ and 2.50×10^6 to 23.34×10^6 MPNg⁻¹) respectively.

VI. BIOCHEMICAL ELEMENTS

The biochemical elements of the study area show that some elements are present in both study areas and some are absence. The rest are either moderately present or absent. Catalase and Citrate are present in both study areas. Coagulase and Urease are moderately present in eucalyptus site and not present at all in Neem site. Oxidase is present in both but in minute quantity (Table 6 and 7).

VII. CONCLUSION

The neem hotspot supports the growth bacteria and fungi microbial load. Bacteria microbial load is not prominent unlike fungi. Therefore, this study gives a basis for further research especially on degree of allelo-chemicals characteristics on the growth of arable crops/plants between neem and eucalyptus shelterbelt since there is no documentation at Kiyawa Shelter belt.

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GROWTH CHARACTERISTICS AND MICROBIAL POPULATION OF AZADIRACHTA INDICA A. JUSS AND EUCALYPTUS CAMALDULENSIS DEHNH SHELTERBELTS AT KIYAWA, JIGAWA STATE

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