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# Evaluation of Soil Physicochemical Properties, Soil Seed Bank and Species Density of Five Plant Communities in Awka Anambra State

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The research study investigated the physicochemical properties of the soil in five different locations around Nnamdi Azikiwe University Awka campus for their above ground and seed bank status with regards to their germination rate and species density. The study areas were located at Cattle grazed field at gariki Amansea, abandoned farmland near Chisco Transportation and Engineering workshop, frequently mowed lawn at Unizik e-library, a Savanna woodland behind the banking plaza Unizik and tropical lowland forest at Botanical garden Unizik. The seed bank investigation was conducted from September 2016 to March, 2017. Analysis of variance was used to test significant differences between seed bank densities among experimental plots at different soil horizons. The soil physiochemical parameters among the experimental plots were also analyzed by one-way analysis of variance. Significant differences were tested at P= 0.05 at 95% confidence intervals. Results revealed the highest value for above ground species was found in tropical lowland forest (53·67±6.11) while the lowest was in cattle grazed field (8.00±0.82). Meanwhile the highest value for seed bank was in the frequently mowed lawn Unizik e-library (93.00±18.00) and

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the lowest was in the forest (6.50±4.95). The comparison of the two groups using T-test revealed that there was a significant difference between the above ground and seed bank values of the tropical lowland forest P=0.003 and also between the above ground and seed bank values of the frequently moved lawn, Unzik e-library P=0.001. More so, the Savanna above ground values and seed bank species value were not significant at P=0.006, as well as cattle grazed field (8.00 ± 0.82) and (50.00± 19.31) at P=0.006. Also, the Savanna plot comparison of above ground (44.50±3.54) and the seed bank (14.00±5.20) revealed significant differences between the two groups at P=0.006. Electrical conductivity was highest in the cattle grazed field (40.00±1.08) and the highest pH value was found in the Unizik e-library (6.19±0.22). Sorensen's coefficient index revealed the highest similarity between above ground and seed bank species occurred in the cattle-grazed field followed by the frequently mowed lawn Unizik e-library (0.196), then the abandoned farmland (0.074), the Savanna (0.060) and the forest (0.025) respectively. Since the similarity is measured between 0 and 1, it means therefore that there is a weak similarity (0.276) between above ground vegetation and the seed bank in the cattle grazed field while the frequently mowed lawn (0.196) above ground similarity with seed bank was very weak. There is no similarity (0.025) between the above ground vegetation and the seed bank in the tropical forest. This seed bank investigation showed that the number of plant species in the seed bank does not reflect the total number of species in the above ground and the soil properties have an impact on the species density of the areas.

*Keywords: Seed bank; vegetation; soil; physicochemical; species; environment; communities; densities.*

## 1. INTRODUCTION

A correlation between environmental factors and plant species richness has been reported [1]. This is due to the profound effect extended by environmental factors on plant growth. No species are suited to every environment. Different plant species have different needs for moisture, soil nutrient content and amount of radiation received. Furthermore, environmental factors such as energy and nutrient availability, control population growth. Conditions leading to an increase in growth rates of competing species result in monopolization of resources by well-adapted species and extinction of less adapted species, which are unable to withstand competition. These process are assumed to affect biodiversity negatively, i.e., reduce plant species richness [2].

To determine the drivers of plant species richness provides insight into ecological process and information for conservation planning. Soil has a particularly large influence on the composition and structure of terrestrial flora [3,4,5,6]. Many studies have reported a positive relationship between plant richness and soil fertility [7]. Other studies on plant richness have highlighted the importance of edaphic conditions in terms of the different adaptation strategie of plant in different soil types [8]. Study by Austin [9] and Pausas et al.[10] suggested that soil has two main effects on plants: direct and resource effects. Direct effects relate to pH, for example, a property of the soil which is not consumed by plants but has a physiological effect on growth, while resource effects relate to nutrients and moisture availability. Heterogeneousness of these properties is supposedly of major importance in explaining variations in plant richness [6], because different species have unique requirement for soil resources and herefore should be restricted to places with a particular set of soil conditions.

Soil pH is an important factor for plant growth. It affects nutrient availability, nutrient toxicity, and microbial activity, as well as extending a direct effect on protoplasm of plant root cells [11,12]. Grime [3]; Gould and Walker [13] found a unimodal relationship between plant richness and pH. In this model species richness declined towards both acidic and alkaline soils, which may relate to the availability and toxicity of soil nutrients.

Different plant species may not have the same range of adaptability and may require a narrow range of pH to survive [11,14,15]. Grassland species richness is highest at a soil pH range of 6.1-6.5 [3]. In acidic soils (pH <6) the essential nutrients such as calcium, magnesium, potassium, phosphorus and molybdenum are depleted or unavailable in a form useable to plants, which leads to nutrient deficiency [11]. Total nitrogen is also very low and the available nitrogen is limited to $NH^{4+}$ form, because nitrification is inhibited [12]. In strongly acidic soils $Al^{3+}$, $Cu^{2+}$, $Fe^{3+}$, $Mn^{2+}$ ions rise to toxic for the majority of plant species [16].

Salinity affects yield, Ayers and Westcot, [17] and germination rate of plants Hayward and Bernstein [18] through an osmotic effect relates to the fact plants extract water from the soil by exerting an absorptive force greater than that which holds the water to soil [17]. The more salt in water the more the osmotic potential and the more energy required by the plant to extract water. As a result, in soils with high salt concentration, plants extract less water than in soils with low salt concentration. Therefore, high salinity may reduce moisture availability to plants and result in plant dehydration [17]. In addition, reduced moisture availability diminishes nutrient uptake, which may further restrict plant growth [19]. Due o the effect of salinity on moisture availability, climatic conditions such as moisture, temperature and light can greatly affect salt tolerance [20].

High level of salts can also result in ion toxicity and nutrient imbalance [12]. This usually relates to excess sodium and more importantly chloride ions, which negatively affects plant enzymes [11]. In addition to the potentially toxic accumulation of $Na^+$ ions in plant tissue, a high Na concentration may also negatively affect soil physical conditions. It may, for example, increase dispersion of soil particles and promote crust formation, which decreases water infiltration [21]. High salt levels also lessen the uptake of several micronutrients, especially Fe [16].

Several investigations have been undertaken on the changes un plant richness along moisture gradients, but to date no consistent general relationships have been found. A number of researchers reported a positive relationship between plant species richness and rainfall [22,23,24,25]. Richerson and Lum [22] for example, investigated the effect of annual rainfall to be the strongest single variable controlling total species diversity as well as tree and herb diversity. Minchin [26] also found a significant positive correlation between species diversity and moisture availability, while Leathwick et al. [27] found that humidity is one of the most important predictors of biodiversity.
Water availability is reported to be one of the most important environmental parameters controlling plant richness [1]. Higher moisture availability enhances plant growth and productivity, which in turn is likely to affect plant diversity.

Sala et al. [28] reported that plant richness was more influenced by soil texture than by rainfall, and suggested that soil texture has a large influence on the location at which water is stored. Fine textured soils store more water near the surface layers than coarse-textured soils. Therefore, fine-textured soils are more favourable for grassy vegetation with shallow root system, compared to woody vegetation with deeper roots. This study seeks to investigate the physicochemical properties of the soil in five different locations around Nnamdi Azikiwe University Awka campus in relation to their above ground species and seed bank status with regards to their germination rate and species density.

## 2. MATERIALS AND METHODS

### 2.1 Description of the Study Area

This study was conducted on five plant communities around Nnamdi Azikiwe University (Unizik) main campus as experimental sites namely:

(a) A cattle-grazed field (Grassland) (Site 1)
(b) An abandoned farmland (Site 2)
(c) A frequently mowed lawn (Site 3)
(d) A derived savanna woodland (Site 4)
(e) A secondary rainforest (Site 5)

All these sites are within Awka, the capital of Anambra State (Latitudes 6º12¹25¹N 7º04¹04¹E/ 6.20694ºN 7.06778ºE coordinates. Awka is sited on a tropical valley but most of the original rainforest has been lost due to clearing for farming and human settlement. The wooded savanna grassland predominates primarily to the North and east of the city. South of the town on the slopes of Awka- Orlu uplands are some examples of soil erosion and gullying.

### 2.2 Climate of Study Area

Awka is in the tropical rainforest zone of Nigeria with two distinct seasons, namely: Rainy season between April to October (7months) with mean precipitation of 602mm and the dry season is between November to March (5 months). The seasons are brought about by two predominant winds that rule the area, the south western monsoon winds from the Atlantic Ocean and the north eastern dry winds from across the Sahara desert. The monsoon winds from the Atlantic creates seven (7) months of heavy tropical rains which occur from April to July followed by a short dry period in August (lasting 2 to 3 weeks) with the rain resuming late August to October. This is followed by 5months of dryness (November to March) marked by harmattan which enters Nigeria in late December or early January and is usually characterized by grey-haze limiting visibility and blocking the sun's rays before dissipating and leading to extreme dry heat in the later months of February and March. The mean annual temperatures range from 27º-30ºC from June to December but rise to 32º- 34ºC from January – April with the last few months of intense heat.

## 2.3 Vegetation of the Study Area

Although reports showed that the annual rainfall is high ranging from 1,400mm in the North and 2500mm in the south, it is concentrated in one season with about 4 months of dryness (November to Febuary). Consequently the natural vegetation in Anambra state is tropical dry or deciduous forest which in its original form comprised tall trees with thick undergrowth and numerous climbers. The tropical trees present are silk cotton trees, Iroko and Oil bean trees, etc., which are deciduous, shedding their leaves in dry seasons. Meanwhile, the southern part of the state where the annual rainfall is higher and the dry season shorter is the natural vegetation marginally tropical rainforest type. However, because of the high population density in the state, most of the forest has been cleared infrastructural developments and cultivation. Presently, the vegetation is a secondary regrowth or a forest savanna mosaic where the Oil Palm predominates together with selectively preserved economic trees. The original vegetation can only be found in inaccessible places and in shrines.

## 2.4 Sampling Techniques

A Geographical Positioning System (GPS) map of each study location was taken before vegetative data collection began which was used in producing the map of the study area (See Fig. 1).

## 2.5 Soil Sampling Method

Each experimental plot (I-V) as mentioned above was sampled. In each experimental plot, the sampled plots were divided into four (4) parts. In each quarter, three (3) randomly selected points was sampled using a soil Auger of 7.5 cm diameter. The different horizons of the soil, 0-5cm, 5-10cm and 10-15cm of the quarta of each of the plots was collected at four points and then mixed together for each site.

## 2.6 Soil Textural Analysis

Soil textural analysis was conducted for all plots sampled. Determination of textural class will be according to USDA classification as follows:

<0.002mm = CLAY
0.002- 0.05mm = SILT
0.05- 2.00mm = SAND

Hydrometer method was used. The following analysis was conducted at FECOLART Laboratory at Kuru, Plateau state. The method by Ibitoye [29] was used.

## 2.7 Soil Moisture Content

Oven-dry method was used to determine the moisture content of the soil samples.

## 2.8 Soil Chemical Analysis

(a) Determination of Total Nitrogen

The complete digestion method was used for this analysis.

(b) Determination of Organic Phosphorus

This was done with Spectrophotometer using blue Molybdate method.

c) Determination of Total $Ca^{2+}$ and $Mg^{2+}$

Total calcium and magnesium was analyzed through the EDTA titration method.

(d) Determination of Soil Organic matter content

The method used for this study was adapted from Anizoba et al. [30].

e) Determination of Soil pH

The BDH method was used for the pH analysis.

f) Determination of Exchange Acidity in Soil Sample Extraction with 1M KCl

About 5gm of air dried soil were weighed into a 250 ml conical flask and about 100ml of extracting solution was added and shaken vigorously for 1hr. The solution was filtered into a conical flask and subsequently into a 100ml volumetric flask and made up with 1M KCl.

g) Determination of $H^+$ and Al $^{3+}$ (Exchange acidity)

Exactly 25ml of KCl extract was pipetted into 250 conical flasks (50ml was used if pH of soil was above 5.0) and 100ml of distilled water was added. Five (5) drops of phenolphthalein indicator was added and titrated with 0.01 NaOH to a first permanent pink end point with alternate stirring. Then a Blank titration was done with 25ml of 2ml KCl. The amount of base used is equivalent to the total amount of acidity ($H^+$ $+Al^{3+}$) in the aliquot solution. The Blank was corrected with NaOH titre on 25ml KCl solution.
To the same flask, 1 drop of 0.01M HCl was added to bring the solution back to the colourless condition. And 10 ml of NaF solution was added. While stirring the solution, the solution was titrated with 0.01M HCl until colour of solution just disappeared. Then 1 or 2 drops of indicator was added after 2mins for color development. The mMol of acid used are equal to the amount of exchangeable Al. If this value was subtracted from the mMol of total acidity from the first titration, the mMol exchangeable $H^+$ value was obtained. The exchangeable $H^+$ and Al in mMol per 100gm of soil was expressed as mMol/100gm = cMol/1kg.

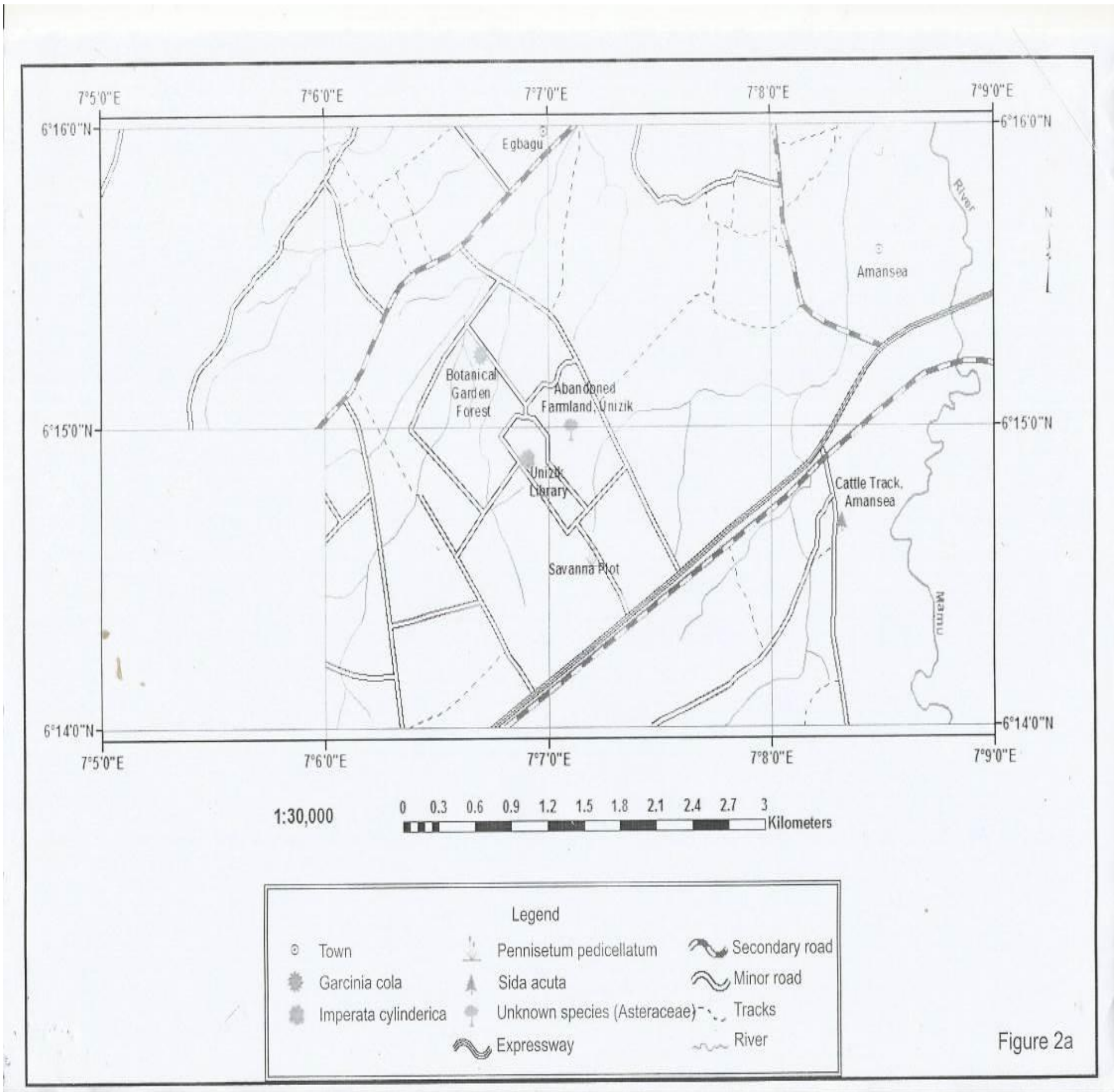


**Fig. 1. Diagram of the study location**

**Calculation**

$$\text{MMol/100g of soil} = T \times M \times \frac{V1}{V2} \times \frac{100}{W}$$

M = Molarity of NaOH
V1 = Volume of extract
V2 = Volume of extract used
W = Weight of soil used

## 2.9 Statistical Analysis

Analysis of variance was used to test significant differences between seed bank densities among experimental plots at different soil horizons. The soil physiochemical parameters among the experimental plots were also analyzed by one-way analysis of variance. Significant differences were tested at P= 0.05 at 95% confidence intervals. Post-hoc test was conducted using Duncan multiple range test. T-test was used for comparisons of relationships between above ground plant communities and seed bank communities. Sorensen's index was applied in the statistical analysis to determine the similarity between above ground species and the seed bank species.

## 3. RESULTS

In all the sampled plots in this study, the soil textural class is Loamy Sandy Soil.

From the table above, the highest value for above ground species was found in tropical lowland forest (53·67±6.11) while the lowest was in cattle grazed field (8.00±0.82). Meanwhile the highest value for seed bank was in the frequently mowed lawn Unizik e-library (93.00±18.00) and the lowest was in the forest (6.50±4.95). The comparison of the two groups using T-test revealed that there was a significant difference between the above ground and seed bank values of the tropical lowland forest P=0.003 and also between the above ground and seed bank values of the frequently moved lawn, Unzik e-library P=0.001. More so, the Savanna above ground values and seed bank species value were not significant at P=0.006, as well as cattle grazed field (8.00 ± 0.82) and (50.00± 19.31) at P=0.006. Also, the Savanna plot comparison of above ground (44.50±3.54) and the seed bank (14.00±5.20) revealed significant differences between the two groups at P=0.006.

From the above table, there is a significant differences in the number of germinated seeds in the Cattle grazed field at 0-5cm depth, 5-10cm and 10-15 cm, P=0.001. There were also significant differences in the abandoned farmland at 0-5cm depth and 5-10 and 10-15 cm respectively, P=0-001. Similarly there is a significant difference in the frequently mowed lawn between 0-5cm and 5-10 and 10-15cm depth. In the Savanna, 0-5cm was significantly different from 5-10cm and 10-15cm depth. In the forest, 0-5cm was significantly different from 5-10cm and 10-15cm respectively.

Further comparison was made using the Sorensen's coefficient index to determine the degree of similarity. From the table above, the result revealed that the cattle grazed field has a highest value (0.276) while the lowest was tropical forest (0.025). Hence the highest similarity between above ground and seed bank species occurred in the cattle-grazed field followed by the frequently mowed lawn Unizik e-library (0.196), then the abandoned farmland (0.074), the Savanna (0.060) and the forest (0.025) respectively. Since the similarity is measured between O and 1, it means therefore that there is a weak similarity (0.276) between above ground vegetation and the seed bank in the cattle grazed field while the frequently mowed lawn (0.196) above ground similarity with seed bank was very weak. There is no similarity (0.025) between the above ground vegetation and the seed bank in the tropical forest.

**Table 1. Soil textural properties of the five sampled plots around Unizik**

| Sample | Particle size | | | Textural class |
|---|---|---|---|---|
| | **Clay (%)** | **Silt (%)** | **Sand %** | |
| Cattle grazed field | 7.88 | 9 | 83.12 | Loamy sand |
| Abandoned farmland | 6.88 | 8 | 85.12 | Loamy sand |
| FML Unizik e-Library | 6.88 | 6 | 87.12 | Loamy sand |
| Savanna | 8.88 | 12 | 79.12 | Loamy sand |
| Lowland forest | 8.88 | 10 | 81.12 | Loamy sand |

**Table 2. Physicochemical components of soil samples from the plant Communities around Unizik**

| Nutrient | Sampled Plots | | | | | F-test | P |
|---|---|---|---|---|---|---|---|
| | Forest | Cattle track | Savannah | ABF | Unizik-e lib | | |
| EC | 17.00±1.36a | 40.00±1.08b | 7.00±0.80c | 15.00±1.00d | 14.00±0.20d | 56.706 | 0.001 |
| pH ($H_2O$) | 5.93±0.88 | 5.66±0.38 | 5.99±0.11 | 5.88±0.18 | 6.19±0.22 | 0.517 | 0.725 |
| pH($CaCl_2$) | 4.40±0.17a | 4.42±0.17a | 4.03±0.07b | 4.61±0.05a | 5.00±0.04c | 24.188 | 0.001 |
| N (ppm) | 47.00±1.41a | 75.00±2.45b | 42.00±1.00c | 77.00±2.00b | 78.00±2.00b | 29.731 | 0.001 |
| P(ppm) | 0.18±0.03cd | 0.16±0.01bc | 0.21±0.03d | 0.14±0.01b | 0.03±0.01a | 39.650 | 0.001 |
| K(ppm) | 10.00±1.41bc | 12.00±1.15c | 6.00±1.00a | 10.00±1.00bc | 8.00±1.00b | 13.147 | 0.001 |
| S(ppm) | 0.56±0.03a | 0.88±0.04c | 0.51±0.03a | 0.66±0.02b | 0.68±0.03b | 80.846 | 0.001 |
| OC (ppm) | 1.87±0.03c | 1.69±0.02b | 1.51±0.03a | 1.52±0.03a | 1.70±0.03b | 12.868 | 0.001 |
| Ca(mMol/100g) | 1.55±0.03a | 0.60±0.03b | 0.85±0.02c | 0.75±0.03d | 0.65±0.03e | 80.635 | 0.001 |
| Mg(mMol/100g) | 0.55±0.02a | 1.30±0.02b | 0.10±0.01c | 0.35±0.03d | 0.75±0.04e | 14.300 | 0.001 |
| EA mMol/100g | 2.00±0.16a | 1.20±0.18b | 2.40±0.17c | 1.60±0.26d | 0.80±0.03e | 40.273 | 0.001 |
| Soil moisture | 25.01±0.01b | 12.02±2.01a | 9.01±0.01c | 20.01±1.03b | 15.01±0.01d | 50.623 | 0.001 |

*Results are means ± standard deviation; Means with different superscripts are significantly different at p<0.05; Keys: EC: Electrical conductivity, N: Nitrogen, P: Phosphorus, K: Potassium, S: Sulphur, OC: Organic carbon, Ca: Calcium, Mg: Magnesium, EA: Exchange acidity*

**Table 3. Comparison of seed bank species and above ground species**

| Plots | Above ground species | Seed bank species | t-test | P |
|---|---|---|---|---|
| Savanna | 44.50±3.54 | 14.00±5.20 | 7.096 | 0.006 |
| Forest | 53.67±6.11 | 6.50±4.95 | 8.987 | 0.003 |
| Abandoned farm land | 20.50±3.87 | 44.00±22.72 | 2.096 | 0.090 |
| Mowed lawn | 21.00±4.08 | 93.00±18.00 | 7.979 | 0.001 |
| Cattle grazed field | 8.00±0.82 | 50.00±19.31 | 4.496 | 0.006 |

**Table 4. Comparison of germination rate of seeds according to communities and depth**

| Communities | Depth | | | | $P_{dept}$ | $P_{com}$ |
|---|---|---|---|---|---|---|
| | **0-5** | **6-10** | **11-15** | **Total** | | |
| Cattle | 46.15±5.80$^{a}$ | 12.25±1.93$^{b}$ | 7.77±1.45$^{b}$ | 22.06±2.53$^{a}$ | 0.001 | 0.001 |
| Abandoned | 30.00±5.92$^{a}$ | 8.21±1.56$^{b}$ | 3.67±1.07$^{b}$ | 13.96±2.27$^{b}$ | 0.001 | |
| FML | 37.33±4.26$^{b}$ | 28.13±3.81$^{a}$ | 15.54±3.04$^{a}$ | 27.00±2.27$^{c}$ | 0.001 | |
| Savanna | 4.10±0.94$^{a}$ | 1.23±0.22$^{b}$ | 2.21±0.52$^{b}$ | 2.51±0.38$^{d}$ | 0.006 | |
| Forest | 2.79±0.52$^{a}$ | 0.75±0.21$^{b}$ | 0.40±0.10$^{b}$ | 1.31±0.21$^{d}$ | 0.001 | |

*Results are in Mean ± Standard Deviation; Means with the different superscripts are significantly different ($p< 0.05$)*

**Table 5. Calculation of Sorensen's coefficient**

| Plot | A | Vegetation (B) | Seed bank (C) | 2A | 2A+B+C | 2A/(2A+B+C) |
|---|---|---|---|---|---|---|
| Cattle-grazed field | 4 | 8 | 13 | 8 | 29 | 0.276 |
| Abandoned farm land | 2 | 34 | 15 | 4 | 54 | 0.074 |
| Unizik E-library | 6 | 39 | 13 | 12 | 61 | 0.196 |
| Savanna | 2 | 53 | 6 | 4 | 67 | 0.060 |
| Forest | 1 | 69 | 4 | 2 | 80 | 0.025 |

*Note A – Number of species in both above ground and seed bank; B- Number of species in above ground only; C- Number of species in seed bank only*

## 4. DISCUSSION

Though emerging seedling from this study gave a reasonably good estimate of the possible field emergence, they represented only a small and variable fraction of the weed seed bank in the soil. This low percentage is in line with the findings of Weiher et al. [6] who found an average of 2.1 - 8.2 % and 6.2 – 11.9 % of the seeds of broadleaf and grass weed species, respectively. Lavers and Field [1] reported 20 - 30 % of the seeds in the soil emerged as seedlings over six months but in contrast to the result of Weiher et al. [6] who obtained 65 - 100 % germination for three quarters of the species over 6 months. Knight et al. [23] also found seedling emergence accounted for about 25 % of the seeds in the soil and that most of those that emerged did so in the first month.

The Electrical connectivity of the soil was the highest 40.00 ± 1.08 in the cattle grazed field among the five sampled plots. It implies that grazing increases electrical conductivity of the soil. The pH ($H_2O$) was 51.66±0.38 while the pH ($Cacl_2$) was 4.42±0.17. The soil moisture content showed that the forest site had the highest moisture content (25.01±0.01b) while the savannah site had the least moisture content (9.01±0.01c). The soil is acidic while N (ppm) was very high (75.00±2.45) and the K (ppm) was recorded at (12.00±1.15). Ca (ppm) was very low (1.30±0.02) and Mg (ppm) was (0.60±0.03). Also, Kioko et al. [31] emphasized that mean exchangeable ions such as Ca(ppm), Mg(ppm), K(ppm), total nitrogen and pH values were very low on grazing fields than in the non grazing area. For this study, the soil was acidic (5.66±0.38) and (4.42±0.07) respectively while the N (ppm) was also very high (75.00 ± 2.45), contradicting Kioko et al. [31].

Previous researches in the tropics have indicated that plants are commonly limited by phosphorus with very few exceptions. Low phosphorus is common with volcanic soils because binding of phosphorus with clay results in high phosphorus retention rates. According to Miao et al [3] percentage organic matter and most nutrient levels are extremely high in the forest which is typical of volcanic soils. Similarly, recent studies comparing nutrient levels in pasture and forest have reported lower levels of cations in the pastures than in primary and secondary forests. Although organic matter and nitrogen levels were high and large portions of the nutrients in volcanic soils may not be readily available to plants due to slow mineralization. However, it was discovered that tropical forest soils are extremely variable with respect to their mineralogy and management history which largely accounts for site specific differences in the extent to which nutrient availability limits forest recovery. Another factor that may limit seed bank emergence is soil compaction which may directly affect seed germination [3]. Therefore successions in abandoned pastures are dependent upon recently dispersed seeds as lack of seed dispersal is a limiting factor.

From this study, seedling emergence was higher in 10-15cm depth (46) than 0-5cm depth (35) and 6-10cm depth (33) respectively. This contradicts the suggestions by Lavers and Fields [1] that highest percentage of seedling emergence occurred in the first year after the seeds are introduced into the soil and also seeds buried between 7.5 to 15cm deeper had lower emergence rates and that increased cultivation but decreased the number of viable seeds. However, studies have discovered that larger and heavier seeds are able to overcome effect of burial depth to some degree having the ability to emerge from deeper heights.

But, according to Anderson [32] valuable species are underrepresented in the seed bank which can be prone to extinction under heavy utilization therefore suggesting an in-situ conservation within certain localities. Considering the report of Manish and Sundaramoorthy [2] seeds in the soil are of two types namely: The transient i.e. those that has brief viability in forest soils and die off and persistent seeds which have extended viability and always associated with phenomenon of dormancy. It is possibly suggested that plants in the cattle grazed field has persistent seeds in their soil seed banks and further studies will reveal the rate and types of dormancy attributed to them thereby determining methods of breaking the dormancy to enforce restoration and regeneration of the destroyed ecosystem through grazing practices.

## 5. CONCLUSION

The research study investigated the physicochemical properties of the soil in five different locations around Nnamdi Azikiwe University Awka campus for their above ground and seed bank status with regards to their germination rate and species density. The study plots were located at Cattle grazed field at gariki Amansea, abandoned farmland near Chisco Transportation and Engineering workshop, frequently mowed lawn at Unizik e-library, a Savanna woodland behind the banking plaza Unizik and tropical lowland forest at Botanical garden Unizik. The vegetative sampling was done between August and September 2015 while the soil sampling was done in October 2015. The seed bank investigation was conducted from September 2016 to March, 2017. This seed bank investigation showed that the number of plant species in the seed bank does not reflect the total number of species in the above ground and the soil properties have an impact on the species density of the areas; therefore restoration of the present plant communities should not be dependent on the seed bank to avoid extinction of the present plant communities.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Lavers C, Field R. A resource-based conceptual model of plant diversity that reassesses causality in the productivity-diversity relationship. Global Ecology and Biogeography. 2006;15:213-224.
2. Manish M, Sundaramoorthy S. Patterns of herbaceous species richness and productivity along gradients of soil moisture and nutrients in the Indian Thar desert. Journal of Arid Environments. 2016:125(80-87).
DIO: 10.1016/j.jaridenv.2015.10.011
3. Miao R, Song Y, Sun Z, Guo M, Zhou Z, Liu Y. Soil seed bank and plant community development in passive restoration of degraded sandy grasslands . Sustainability. 2016;8:581.
Available:https://doi.org/10.3390/su8060581
4. Huston MA. Soil nutrients and tree species richness in Costa Rican forest. Journal of Biogeography; 1980.
5. Tilman, D. Resource competition and community structure. Princeton University Press, Princeton; 1982.
6. Weiher E, Forbes S, Schauwecker T, Grace JB. Multivariate control of plant species richness and community biomass in black land prairie. Oikos. 2004;106:151-157.
7. Wright SJ. Seasonal drought, soil fertility and species density of tropical forest plant communities. Trends in Ecology and Evolution. 1992;7:260-263.
8. Richards MB, Stock WD, Cowling RM. Soil nutrient dynamics and community boundaries in the Fynbos vegetation of South Africa. Plant Ecology. 1997;130:143-153.
9. Austin MP. Spatial prediction of species distribution: An interface between ecological theory and statistical modeling. Ecological Modelling. 2002;157(2-3):101-118.
10. Pausas JG, Carreras J, Ferre A, Font X. Coarse-scale plant species richness in

relation to environmental heterogeneity. Journal of Vegetation Science. 2003;14:661-668.
11. Larcher, W. Physiological Plant Ecology. Springer-verlag. New York; 1980.
12. Marschner H. Mineral nutrition of higher plants. Academic Press. London; 1986.
13. Gould WA, Walker MD. Plant communities and landscape diversity along a Canadian Arctic river. Journal of Vegetation science. 1999;10:537-548.
14. Grubb PJ. Plant population and vegetation in relation to habitat, disturbance and competition: problems of generalization. P. In J. White, ed. Dr. W. Junk publishers. Dordrecht; 1985;595-621
15. Leskiw LA. Land capability classification for forest ecosystem in the oil sands region. Alberta environmental protection. Edmonton; 1998.
16. Wolf B. The fertile triangle. The interrelationship of air, water, and nutrients in maximizing soil productivity. Food products press. New York; 2000.
17. Ayers RS, Westcot DW. Water quality for agriculture. FAO irrigation and drainage papers. Food and agricultural organization of the United Nations. Rome; 1985.
18. Hayward HE, Bernstein L. Plant-growth relationship on salt-affected soils. Botanical Reviews. 1958;24:584-635.
19. Allen JA, Chambers JL, Stine M. Prospects for increasing the salt tolerance of forest trees: A review. Tree Physiology. 1994;14:843-853.
20. He M, Lv L, Li H, Meng W, Zhao N. Analysis on soil seed bank diversity characteristics and its relation with soil physical and chemical properties after substrate addition. PLoS ONE. 2016;11(1):e0147439. Available: https://doi.org/10.1371/journal.pone.0147439
21. McBride MB. Environmental chemistry of soils. Oxford University Press. Oxford; 1994.
22. Richerson PJ, Lum KL. Patterns of plant species diversity in California: relation to weather and topography. American Naturalist. 1980;116:504-536.
23. Knight RS, Crowe TM, Seigfried WR. Distribution and species richness of trees in southern Africa. Journal of South African Botany. 1982;48:455-480.
24. Gentry AH. Changes in plant community diversity and floristic composition on environment and geopolitical gradients. Annual Monograph Botanical Garden. 1988;75:1-34.
25. O'Brien EM. Climatic gradient in woody plant species richness: towards an explanation based on an analysis of southern Africa's woody flora. Journal of Biogeography. 1993;20:181-198.
26. Minchin PR. Montane vegetation of the Mt. field massif, Tasmania: a test of some hypotheses about proprieties of community patterns. Vegetatio. 1989;83:97-110.
27. Leathwick JR, Burns BR, Clarkson BD. Environmental correlates of tree alpha-diversity in New Zealand primary forests. Ecography. 1998;21:235-246.
28. Sala OE, Lauenroth WK, Golluscio RA. Plant functional types in temperate semi-arid regions, In TM. Smith, Shugart, HH. And Woodward, FI, ed. Plant functional types. Their relevance tp ecosystem properties and global change. Cambridge University Press. Cambridge. 1997;217-233.
29. Ibitoye AA. Laboratory Manual on Basic Soil Analysis. 3rd edition. Foladave Ltd. Akure. 2008;240.
30. Anizoba MA, Ebenebe CI, Okeke JJ. Basic ecological exercises. A student guide to field work and analysis. SCOA Heritage systems (Educational Publishers), Awka. Anambra state. 2006;79.
31. Kioko J, Kirinnge JW, Seno SO. Impacts of livestock grazing on a savanna grassland in Kenya. Journal of Arid land. 2012;4(1):29-35.
32. Anderson TM, Schutz M, Risch AN. Seed germination clues and the importance of soil seed bank across an environmental gradient in the Serengeti. Nordic Society Oikos: 2011;1-7.



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