Evaluation of Soil Physicochemical Properties on Soil Seed Bank of Five Plant Communities in Awka Anambra State

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 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. 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 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 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. 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.

KEYWORD: 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, located near Gariki, Amansea town (Site 1)

(b) An abandoned farmland near Chisco building, Unizik (Site 2)

(c) A frequently mowed lawn behind the Unizik e-library (Site 3)

(d) A derived savanna woodland behind the Unizik banking plaza (Site 4)

(e) A secondary rainforest at the Unizik botanical garden (Site 5)

The cattle grazed field, which is located in an abandoned area formerly proposed site for construction of housing estate after the gariki market Amansea, in Awka south in Anambra State while the abandoned farmland is located opposite the Chisco engineering workshop in Unizik campus. The site was abandoned for three years. The frequently mowed lawn is located near the Unizik e-library. The lawn is mowed quarterly and subsequently four times annually with mowing machines. The savanna woodland is located behind the Unizik banking plaza while the tropical rain forest is located in the Unizik botanical garden which is located in the science village.

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.

Awka the capital of Anambra State has a total area of 4844 km² and is situated on 136 meters above sea level. The city is located 199.1 kilometers (123.7 miles) by road directly north of Port Harcourt.

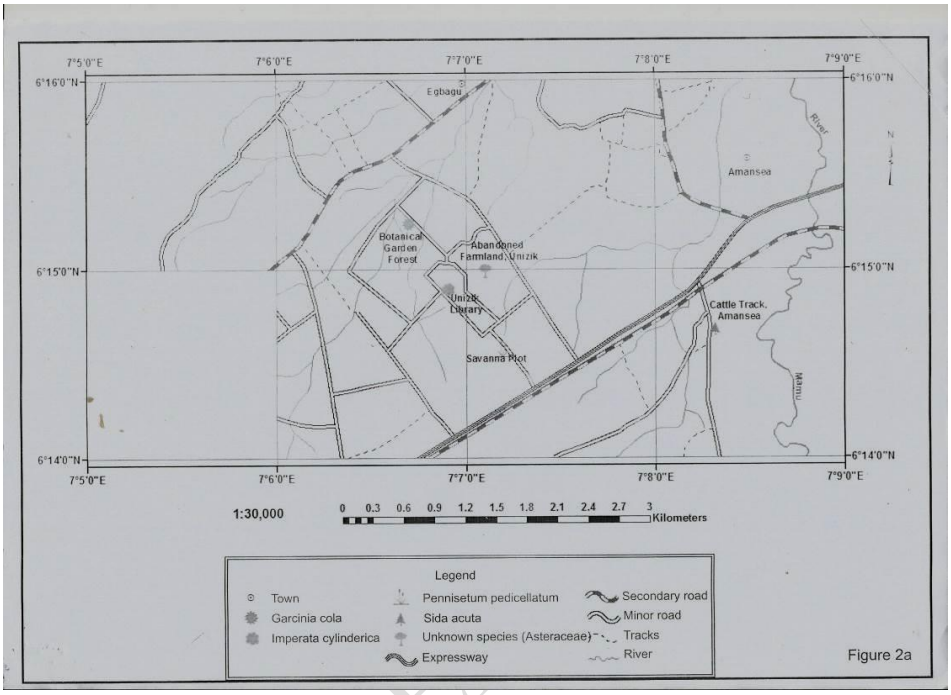

Figure 1: Diagram of the study location

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 Sahara desert. The monsoon winds from the Atlantic creates seven (7) months of heavy tropical rains which occurs 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 a 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 ranges from 27º-30ºC from June to December but rises to 32º- 34ºC from January – April with last few months of intense heat. 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.

2.3 Sampling Techniques

A 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)

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What materials did you use during collection?

2.4 Soil Textural and Chemical Analysis

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2.4.1 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 (2008) was used.

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2.4.2 Hydrometer method

Fifty (50) grams of 2mm sieved oven dried soils were put into a 250ml beaker. 100mls of Calgon was added and allowed to soak for 30mins. The solution was transferred to a dispersing cup. The suspension was stirred for about 3mins with mechanical stirrer. Then it was transferred quantitatively to a sedimentation cylinder and filled to the mark with distilled water while calibrated Hydrometer (Model hydrometer OMSONS no 2720) was immersed into it. The plunger was inserted and moved up and down to mix the contents thoroughly. The sediments were dislodged with strong upward strokes of the plunger near the bottom and by spinning the plunger while the disk is just above the sediment. Stirring was finished with two or three slow smooth strokes. The time of completion of stirring was recorded and a drop of amyl alcohol was added because the surface of suspension is covered with foam. Also, the hydrometer was lowered carefully into the suspension and readings taken after 40 secs. Then the hydrometer was removed from the suspension and the temperature of the suspension recorded using a thermometer.

Repeat the mixing of the suspension and the 40seconds reading was repeated until a reliable reading was obtained. The readings were done every two hours (2hrs) after the final mixing was done. Also, the temperatures were recorded along with the hydrometer readings. After 40 seconds, the sand particles were differentially settled (Silt and Clay remained in the suspension). Then 2 hours after, all the sand and silt were settled and only clay was remaining in the suspension.

NOTE: The stem of the hydrometer reads directly in grams of soil/litre of suspension. To correct the hydrometer reading, for temperature, add 0.36g/litre for every 1ºC above 20ºC and subtract 0.36g for every 1ºC below 20ºC.

Calculations

$$\% \text{ Silt + Clay} = \frac{(R40 \text{ secs} - Ra) + Rc}{\text{Weight of soil}} \times 100$$

$$\% \text{ Clay} = \frac{(R2\text{hours} - Rb) + Rd}{\text{Weight of soil}} \times 100$$

Ra = 40 seconds blank hydrometer reading

Rb = 2 hours blank hydrometer reading

Rc = 40 seconds correction factor (Temperature X 0.360)

Rd = 2 hours correction factor (Temperature X 0.360)

% (sand + silt + clay) = 100

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Calibration of Hydrometer
Exactly 100ml of Calgon was added to the cylinder and was used to make up the volume to 1 litre with distilled water. The solution was mixed thoroughly with the plunger. The hydrometer was lowered into the solution carefully and the scale reading was determined (R) for 40 seconds reading and 2 hours reading was taken.

2.4.3 Soil Chemical Analysis

(a) Determination of Total Nitrogen
This involves complete digestion of the soil samples in Conc. H_2S0_4 in presence of metal catalyst. The catalyst was to convert all nitrogen in the nitrogenous materials in the sample into ammonium ion. Upon addition of an alkali, the samples were digested and ammonia was released which may be distilled out of sample or determined by simple acid – base titration. Exactly 0.42g Se and 14g Li_2S0_4 was added to 350 ml 30% H_20_2 and mixed thoroughly. Then 420 ml conc. H_2S0_4 was carefully added and cooled and stored. In this study, the catalyst used was Potassium sulphate and Copper sulphate. Also the other reagents prepared and used were incorporated into the procedure used for the analysis.

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Procedure for Digestion
A 2g of soil sample was weighed and put into 500ml Kjeldahi flask and 20ml of concentrated H_2S0_4 with one Kjeldahl catalyst tablet or 1 gram of catalyst mixture was added per sample. In this study, the catalyst mixture was used as mentioned above. The flask with the content was heated on the digestion stand until solution became clear and soil residue remaining was white. It was heated further for few minutes to ensure complete digestion and then allowed to cool. Fifty (50ml) deionized water was added and mixed well and then allowed to cool. The mixture was decanted or filtered and was transferred to 100ml volumetric flask and was made to reach 100ml mark using deionized water. Meanwhile, the Blank digestion (all the reagents but without sample made up to 100ml and was used to determine nitrogen as well). Nitrogen is usually converted to ammonia and reacted with H_2S04 to form $(NH_4)_2$ $S0_4$. The process of digestion was followed by distillation.

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Distillation and Filtration
The steam distillation unit was set up and 5ml of Boric acid was placed into the flask. The boric acid solution in the flask usually receives and traps down free ammonia vapour liberated from the digest extract. Three (3) drops of mixed indicator were added. The receiving flask was placed at the tip of the condenser tube, below the surface of boric acid solution. Then 10ml of digest was transferred to the reaction chamber and 10ml of 40% NaOH was added. The joints were closed and distillation commenced and 50ml of the distillate entered inside the receiving flask.

The distillate was titrated with 0.01M HCl or 0.025M H_2S0_4

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(b) Determination of Organic Phosphorus
This was done with Spectrophotometer using blue Molybdate method.

Procedure
About 2g of soil was weighed and sieved with 2mm into a crucible with a sieve. Then, the soil was ignited at 550ºC for 1 hour in a muffle furnace and removed after 1 hour. It was allowed to cool at room temperature. Thirty 30mls of 0.1M H_2SO_4 was added to the ignited sample and to the same weight of unignited sample. The mixtures were stirred and filtered into 100ml standard flask and the solution was brought to the mark with distilled water. Determination of the Phosphorus in ignited and unignited extracts was done using colorimeter or spectrophotometer.

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Spectrophotometeric Analysis
The blue Molybdate method was used. It is a combination of orthophosphate with ammonium molybdate in acidic medium to form Molybdphosporic acid. H_3PO_412 $MoO_{32}4H_2O$. This was further reduced to Molybdenum blue complexes by reacting with ascorbic acid.

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Composition of other chemical compounds used for the analysis

i. Twelve (12) grams of Ammonium molybdate was dissolved in 250ml of deionized water and 0.291g antimony potassium tartrate and 100ml deionized water was added. Both solutions with the deionized water were mixed thoroughly. (The mixture was stored in a Pyrex glass bottle and kept in the dark).

ii. Ascorbic acid solution 0.53% was added to the reagent above.

iii. A Standard Phosphorus solution was also added.

$$1000\text{ppm} = \frac{KH_2PO_4}{P} = \frac{136}{31} = 4.39\text{g/ litre.}$$

4 .39g/liter = 100ppm. Then 10ml of 100ppm diluted to 100ml will be 10ppm.

iv. A Phosphorous free detergent was used for washing.

Procedure for spectrophotometer determination

A standard spectrophotometer 20D: Techmel and Techmel. USA. No 201001006 was used.

Standard Serial Solution Preparation

A total of 0.5, 1, 2, 4, 5mls of soil supernatant was pipetted and 10mls from 10ppm into 50ml volumetric flask and 8mls of 0.53% ascorbic acid solution. And then 5-10mls of sample extract or digest was pipetted into 50ml volumetric flask. Then about 8ml of Ascorbic acid solution made up to 50ml in standard flask with distilled water and allowed to stand for 30minutes. The Absorbance of serial standards was read at 660nm. Also, the absorbance of other soil samples was read at the same wavelength.

c) Determination of Total Ca^{2+} and Mg^{2+}through EDTA titration method

Twenty (20) mls of soil samples were pipetted into250mls conical flask. 100 mls of ionized water was added. Then, 15mls of conc. Ammonium solution (used as buffer) or NH_4Cl. + NH_3 buffer, 28mls conc. Ammonia solution plus 70grams ammonium chloride ($OHNH_3Cl$). (5g $OHNH_2HCl$) in 100ml deionized H_2O). Then 4 drops of Erichrome black T indicator was added. The above mixture was titrated with 0.01M EDTA from wine red colour to deep blue end point. The titration was repeated and the mean value was obtained

For Calcium ion determination

20mls of sample was pipetted into 250ml conical flask and 100ml of deionized water was added. 10mls of 20% KOH (20 g KOH made 100ml with deionizes water) was added. Then about 10 drops of 2% KCN was added followed by 10drops of 5% hydroxyl ammine hydrochloride ($OHNH_2HCl$). A pinch of calcine indicator or Alizarin Black indicator was added. Titration was done with 0.01M EDTA and the colour changed from wine red to deep blue. Titration was repeated and the mean value taken.

Assuming Mg + Ca = 5.10 and Ca alone = 3.10. Then Magnesium ion is determined by subtraction. Mg = (Mg + Ca) – Ca.

v. **Determination of Soil Organic matter content**

The method used for this study was adapted from Anizoba *et al.* (2006)

Procedure

i. The soil samples were oven dried.
ii. Then the crucible was weighed and the weight (W) recorded.
iii. The soil samples were placed into the crucible and reweighed and the weight recorded (Wi)
iv. Then the crucible and the soils were placed in the Oven at 500 º C to 700º C. It was left for 2hrs.
v. The crucible was removed from the Oven using tongs, and allowed to cool.
vi. The cooled crucible and its contents were weighed and recorded (W2).

Calculations

a) Weight of soil before heating = (Wi – W)gm
b) Weight of soil after heating = (W2 – W) gm
c) Weight of Organic matter in soil sample = (Wi – W) – (W2 – W)

$$\text{Percentage organic matter} = \frac{(Wi - W) - (W2 - W)}{(Wi - W)} \times 100$$

e) Determination of Soil pH

Procedure

i) About 1gm of soil from each study site was added to the test tube and 1gm of barium sulphate was added accordingly.
ii) 10cc distilled water and 5cc of BDH Universal indicator solution was added to each test tube and sealed with the rubber bung. The content was shaken vigorously and left to settle for 5mins.
iii) Comparison of the colour of the liquid in the test tube with the colours on the BHD was made and from the Reference colour chart read off the corresponding pH.
iv) Repeat the experiment on soil samples from different areas.

f) Determination of Exchange Acidity in Soil Samples
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.

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

2.5 Computation of Data

After sampling, in order to quantify specie density and specie abundance the following statistical analysis was computed as follows:

$$\text{Density} = \frac{\text{No of each specie}}{\text{Total area sampled}}$$

$$\text{Relative density} = \frac{\text{Density of each species}}{\text{Total density of all species}} \times \frac{100}{1}$$

$$\text{Frequency} = \frac{\text{No of times a specie occurred}}{\text{Total no of times searched for}} \times \frac{100}{1}$$

$$\text{Relative freq.} = \frac{\text{Frequency of each specie}}{\text{Total frequency of all species}} \times \frac{100}{1}$$

Important value Index = Relative density + Relative frequency

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2.6 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.

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3. RESULT

Table 1: Physicochemical components of soil samples from the Plant Communities around Unizik

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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

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Results are means ± standard deviation()

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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*.

Electrical Conductivity (EC)

EC was highest in the cattle grazed field (40.00±1.08) and least in the Savanna (7.00±0.80). There was significant difference between the forest's EC (17.00±1.36) and that of cattle grazed field (40.00±1.08), Savanna (7.00±0.80) and Abandoned farmland (15.00±1.00) at P=0.001. However, there is no significant difference between EC of abandoned farmland (15.00±1.00) and Unizik e- library (14.00± 0.20).

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pH (H_20)

The highest pH value was found in the Unizik e-library (6.19±0.22) while the least was found in cattle grazed field (5.66±0.38). There was no significant difference in the pH values of the five sampled plots. P=0.725.

pH ($Cacl_2$)
The highest value was Unizik e-library (5.00±0.04) and the least in the savanna soil (4.03±0.07). However, there was significant difference between Unizik e-library (5.00±0.04) and abandoned farmland (4.61±0.05) and savanna (4.03±0.07) at P=0.001. Meanwhile, there is no significant difference between forest (4.40±0.17) and cattle grazed field (4.42±0.17) and abandoned farmland (4.61±0.05).

N (ppm)
The highest value was Unizik e-library (78.00±2.00) while the least value was in savanna plot (42.00±1.00). Meanwhile there is significant difference between forest (47.00±1.41) and cattle grazed field (75.00±2.45) and the savanna (42.00±1.00) respectively, P=0.001. Also no significant difference was found between cattle grazed field (75.00±2.45), abandoned farmland (77.00±2.00) and Unizik e-library (78.00±2.00) respectively.

P (ppm)
The highest value was the savanna (0.21±0.03) while the lowest was Unizik e-library (0.03±0.01). There is significant difference between forest (0.18±0.03), Unizik e-library (0.03±0.01) and the abandoned farmland while no significant difference between forest (0.18±0.03) and cattle grazed field (0.16±0.01) and savanna (0.21±0.03).

K (ppm)
The highest value was in cattle grazed field (12.00±1.15) followed by Forest (10.00±1.41) and the least was in Savanna (6.00±1.00). However there was significant differences between forest (10.00±1.41) and savanna (6.00±1.00) and between cattle grazed field (12.00±1.15) and Savanna (6.00±100). Also between Savanna and Abandoned farmland (10.00±1.00) and Unizik e-library (8.00±1.00) at P=0.001. Meanwhile, there was no significant difference between forest (10.00±1.41) and cattle grazed field (12.00±1.15) and abandoned farmland (10.00±1.00) and Unizik e-library (8.00±1.00)

S (ppm)
The highest value was cattle grazed field (0.88±0.04) and least in savanna (0.51±0.03). No significant difference occurred between forest (0.56±0.03 and savanna (0.51±0.03) and between Abandoned farmland (0.66±0.02) and frequently mowed lawn Unizik e-library (0.68±0.03). Meanwhile, there is significant difference between cattle grazed field (0.88±0.04), forest (0.56±0.03) and savanna (0.51±0.03) respectively at P=0.001. Also, there is a significant difference between Savanna (0.51±0.03), Abandoned farmland (0.66±0.02) and Unizik e-library (0.68±0.03) respectively at P= 0.001

Organic carbon (OC)
The highest value occurred in forest (1.87±0.03) and the least occurred in savanna (1.51±0.03). There was significant differences between forest (1.87±0.03), cattle grazed field (1.69±0.02) and Savanna (1.51±0.03) respectively at P= 0.001. No significant difference occurred between savanna (1.51±0.03) and abandoned farmland (1.52±0.03) and between cattle grazed field and Unizik-e-library (0.14± 0.01) and (1.70 ±0.03) respectively.

Cal (mMol/100g)
The highest value was revealed in forest (1.55±0.03) and least was in cattle grazed field (0.60±0.03). However, significant differences occurred between forest (1.55±0.02), cattle grazed field (0.60±0.03), savanna (0.85±0.02) and abandoned farmland (0.75±0.03). Also, there was significant difference between abandoned farmland (0.75±0.03), savanna (0.85±0.02) and cattle grazed field (0.60±0.03). Cattle grazed field was significantly different from savanna (0.85±0.02), abandoned farmland (0.75±0.03) and Unizik e-library (0.65±0.03) at P = 0.001.

Mg (mMo1/100g)
The highest mean value was cattle grazed field (1.30±0.02) while least was savanna (0.10±0.01). There were significant differences among the five sampled plots i.e forest (0.55±0.02), cattle grazed field (1.30±0.02) and savanna (0.10±0.01), abandoned farm land (0.35±0.03) and unizik e-libray (0.75±0.04) respectively; also between cattle grazed field (1.30±0.02) and savanna (0.10±0.01) and Abandoned farmland (0.35±0.03) and Unizik e-library at P=0.001.

Exchange Acidity (mMol/100g)

The highest value was Savanna (2.40±0.17) and lowest was Unizik e-library (0.80±0.03) respectively. There were significant differences between forest (2.00±0.16), cattle grazed field (1.20±0.18) and Savanna (2.40±0.17); abandoned farmland (1.60±0.26) and Unizik e-library (0.80±0.03) respectively at P = 0.001.

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Table 2: 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

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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.

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Table 3: 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

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

Table 4: Comparison of germination rate 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	$37.33±4.26^{a}$	$28.13±3.81^{a}$	$15.54±3.04^{b}$	$27.00±2.27^{c}$	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)

From the above table, there is a significant differences in the number of emergence 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.

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

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.

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 Rahman *et al*. (2006) who found an average of 2.1 - 8.2 % and 6.2 – 11.9 % of the seeds of broadleaf and grass weed species, respectively. Ball & Miller (1989) reported 20 - 30 % of the seeds in the soil emerged as seedlings over six months but in contrast to the result of Rahman et al (1998) who obtained 65 - 100 % germination for three quarters of the species over 6 months. Jensen (1969) 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_{20}) was 51.66±0.38 while the pH ($Cacl_2$) was 4.42±0.17. The soil is strongly 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. (2012) 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 (2012).

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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 (Holl, 1999) 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 (Holl, 1999). 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 Harbuck (2007) 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, Grundy et al (2003) 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 (2011) 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 Dainou et al (2011) 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.

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