Survey of Soil Seed Bank in Three Watersheds across Nnamdi Azikiwe University, Awka Campus

ABSTRACT
Soil seed banks survey of three watersheds located across the Awka campus of Nnamdi Azikiwe University was carried out using standard field procedures. Soil samples were collected from two points (P1 and P2) in each of the watersheds at depths of 0-5cm, 5-10cm and 10-15cm. The soil samples collected were spread and watered daily to allow sprouting of seeds. After germination, plants were allowed to grow for an additional 2 weeks; taxonomic identification and classification of all the plant species in every soil sample collected was carried out. The plant species were identified and classified considering observable morphological features with the aid of a flora. The abundance measures analyzed includes: density, frequency, relative density, relative frequency, importance value, species diversity using Shannon-Wiener index. A total of one hundred and eighty-seven (187) plants germinated from the total of eighteen soil samples collected from different points at the study sites. Twenty five (25) species of plants were identified within 13 families. The study revealed that the families Fabaceae, Amaranthaceae and Solanaceae had 2 species each; Euphorbiaceae, Mimosaceae, Malvaceae, Portulacaceae, Cucurbitaceae, Urticaceae and Commelinaceae all had 1 species each. A total of five families were recorded for grasses while Asteraceae family had four species. The family Poaceae had the highest number, 5 species and the family Cyperaceae had 3 species. From the above results, the families that had the most common herb species were Poaceae, Asteraceae and Cyperaceae. The results also revealed that a good number of plant species showed very high Importance Value Index (IVI) of above 50%. The results of Shannon- Weiner index of Diversity for the study area was higher in site A point 1 at 0-5 cm depth (1.196), site B point 1 at 0-5 cm depth (2.136) and site C point 1 at 0-5 cm depth (2.314). The results of this study portray significant soil seed bank potentials of the study area because it showed a wide range of species diversity and abundance.

Keywords: Soil, Seed bank, Watershed, Species, Diversity, Plants, Abundance, Distribution.

1. INTRODUCTION

Soil seed bank describes the natural storage of seeds in the soil of any ecosystem which serve as a preservation for the production of subsequent generation of plant to enhance their succession and survival. The viable seed store or reservoir available in a soil which replaces the vegetation and probably forest after destruction by any agent is referred to soil seed bank. This reservoir or store corresponds to the seeds that did not germinate but, morphologically and physiologically capable of replacing the annual senesce plants, which had disappeared by both natural and artificial death and perennial plants that are susceptible to plant diseases, disturbance and animal consumption, including man [1]. The soil seed bank is composed of viable seeds present in the soil or mixed with soil debris [2]. The soil seed bank is the life cycle origin for the annual species, being fundamentally the cause of its persistence; in perennials, besides the seed bank, there is a bank of vegetative propagules like tubers, rhizomes and stolons [3]. It is often an important plant survival mechanism of many plants and for maintaining long-term stability of ecosystem in the presence of various environmental stresses in the ecosystem such as drought, cold, wildfire, disturbance and other biotic and abiotic factors.

Weed seed banks have been studied intensely in agricultural science because of their important economic impacts; other fields interested in soil seed banks include forest regeneration and restoration ecology [4].

Nnamdi Azikiwe University, Awka landscape constitutes several watersheds which channel and drain precipitation and rain water to the main water body or outlets and these watersheds is continuously increasing consequently due to; the increasing number of human population (students, staffs, workers, laborers etc.), development and constructions, agricultural activities, biological and geological research work, social trends and so many other activities. This watershed is among the types of ecosystem found within this citadel of learning (institution/environment) which include forest ecosystem, wetland ecosystem and some other types. The gross structure of this watershed, its headwaters area, side slope, as well as its soil are potential natural soil seed banks preserving the seeds against physical, mechanical and chemical attacks and damages.

The knowledge of watershed ecology and the seeds stored in its soil give us incite about the surrounding forest ecology, wetland ecology and environmental ecology at large. Along the watershed boundaries; seeds, sediments and dissolved materials may be transported and/or translocated from one point to the other or deposited at any point. A good knowledge of the seed bank and mineral component of the soil of watershed boundaries is essential for the prediction of the community succession, population and community component of that area. Soil seed bank is one of the watershed's structural and functional characteristics that can influence the natural communities, biological activities as well as human activities that coexist within the area. The development of integrated weed management system is a hard and complex task, and can be efficient if there is a complete understanding of the weed population dynamics [5]. The seed bank reflects the historical process of the plant life cycle, from its establishment in the environment to the distribution in time and space.

According to Carvalho and Favoretto [6], the success of a seed bank depends on the seed density ready to germinate, when replacement of plant is necessary and when environmental conditions for establishment is favorable. The longevity of seeds represents a major mechanism of survival of certain weed species, and this leads to a continuous source of emergence. Weed seed banks being important sources of annual weeds in most cropping systems usually represent control measures in the life cycle of the weeds. Therefore, weed seed bank provides physical history of failures and successes of cropping systems and management. Luschei [7] highlighted the effect of cropping systems on weed seed bank composition, density and diversity.

This study was carried out to survey and determine the composition, distribution and abundance of soil seed bank in watersheds across Nnamdi Azikiwe University Awka campus Anambra State.

2. MATERIALS AND METHODS

2.1 Study Site

Three different sites of watershed were selected for this study and each measure 10 metres away from the stream. These areas were tagged A, B, and C

A: Stream located in Science Village
B: Stream located along Faculty of Agriculture main entrance
C: Stream located beside Department of Botany laboratory

There are two (2) random points (P1 and P2) in each area. These random points have three (3) ranges of soil depth; from 0-5cm, 6-10cm and 11-15cm. soil samples were collected from each depth using a soil auger.

After the collection, these soil samples were taken to the department of Botany screen house Nnamdi Azikiwe University Awka where they were sampled and observed for further studies.

2.2 Methods of Collection of Soil Samples

The collection of soil samples in the watersheds was carried out with the use of;

- Soil auger for collecting soil samples
- Knife for clearing and
- Pegs for marking out of area,
- Meter rule for measures both area and depth,
- Collection bag for collection of soil samples from the sites to the screen house,
- Masking tape for labeling.

Other materials include; hand glove and documenting materials

Each site of the watershed was mapped out using a meter rule with the area of $900cm^2$ (30cm by 30cm). A depth of 15cm was established in each site in the following order:
0cm-5cm
5cm-10cm
10cm-15cm

The soil from each depth was collected into a collection bag and taken to the green house where they were spread out on a flat surface for germination of seeds to occur, so as to determine the seeds stored in them. The total number of plant species found in each site was recorded.

2.3 PARAMETERS MEASURED

Date of sample collection: the soil samples were collected on 14th March, 2021. Nine days after the collection; tiny outgrowths of plants were observed. And these outgrowths were observed in soil samples from site A and C which is Science village watershed and watershed beside department of botany laboratory respectively. At site A the outgrowth was at point 2 (0-5 cm) depths while at site B the outgrowth was at point 1 (5cm-10cm) depth. Other soil levels showed no growth as at that date. After two weeks and three days, other levels of the soil samples showed more growth.

Number of plant growths: Number of total plant growth as at 5th May, 2021, that is after one month and three weeks of sample collection from the three sites was as follows:

Site A	Point1	(0-5cm)	22 outgrowths
		(5-10cm)	12 outgrowths
		(10-15cm)	5 outgrowths
	Point 2	(0-5cm)	17 outgrowths
		(5-10cm)	9 outgrowths
		(10-15cm)	2 outgrowths
Site B	Point 1	(0-5cm)	24 outgrowths
		(5-10cm)	13 outgrowths
		(10-15cm)	4 outgrowths
	Point 2	(0-5cm)	18 outgrowths
		(5-10cm)	5 outgrowths
		(10-15cm)	4 outgrowths
Site C	Point 1	(0-5cm)	24 outgrowths
		(5-10cm)	12 outgrowths
		(10-15cm)	3 outgrowths
	Point 2	(0-5cm)	11 outgrowths
		(5-10cm)	3 outgrowths
		(10-15cm)	no growths

2.4 TAXONOMICAL IDENTIFICATION

After germination and growth to an extent, taxonomic identification and classification of all the plant species in every soil sample collected was carried out. The plant species were identified and classified considering observable morphological features with the aid of a flora, West African Weeds and Vascular Plant Taxonomy by Akobundu and Agyakwa [8].

2.5 STATISTICAL ANALYSIS

The following abundance measures were estimated, analyzed and calculated statistically:

i) Density
ii) Frequency
iii) Relative density
iv) Relative frequency
v) Importance value
vi) Species diversity using Shannon-Wiener index

The above stated abundance measures of the population is explained and calculated using the formula as shown below:

Density: This is the number of individuals of a given species that occurs within a given sample unit or study area. It is often used in a vegetation survey to describe a species status in a plant community. Mathematically it is expressed as:

$$\text{Density} = \frac{\text{total number of individual counted}}{\text{Total area}}$$

Relative Density: It is the number of a given species expressed as a percentage of all species present. It is usually expressed as relative value. Relative density is calculated by dividing the density by the sum of the densities of all species, multiplied by one hundred. That is

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

Frequency: This is the number of times a plant species occurs in a particular study area or sample unit. It is usually expressed as a percentage and sometime called frequency index. Frequency is used to quantify and describe the distribution of a species in a community. Also frequency is often used to compare plant communities and to detect changes in vegetation composition over time. It is expressed mathematically as:

Frequency = $\frac{\text{Number of times a species occurred}}{\text{Total number of time searched for}} \times 100$

Relative Frequency: The frequency of a given species expressed as percentage of the sum of frequency values for all species present.

Relative Frequency = $\frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100$

Importance Value:

Importance Value = Relative frequency + Relative density

Shannon-Wiener Index of species diversity

This is a diversity index also called phylogenetic index which is a quantitative measure that reflect how many species that is contained in a community or dataset and can be simultaneously taken into account. The Shannon index has been a popular diversity index in the ecological literature. It is most often calculated using the formula;

$$H' = -\sum_{i=1}^{R} pi\ lnpi$$

Where:

H= the Shannon diversity index

Pi = fraction of the entire population made up of species

S = number of species encountered

$\sum$ = sum from species 1 to s

In = natural logarithm

To calculate the index:

1. Divide the number of individual species by the total number of individual of all species. This is pi
2. Multiply the fraction by its natural logarithm (lnpi)
3. Repeat this for all the species encountered
4. Sum all the –(pi ln pi) products to obtain the value of H

3. RESULT

One hundred and eighty-seven (187) plants germinated from the total of eighteen soil samples that were collected from the study sites. The species compositions, distribution and abundance measures for each soil sample are recorded in tables. Twenty-five plant species are identified from the total germinated plants.

Table 1: Species Abundance of Site A Point 1

0-5cm depth							
S/N	**Species**	**Family**	**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Ageratum conyzoides*	Asteraceae	44.4	18.2	22.2	18.2	36.4
2.	*Carex pendula*	Cyperaceae	33.3	13.6	16.7	13.6	27.2
3.	*Commelina diffusa*	Commelinaceae	22.2	9.1	11.1	9.1	18.2
4.	*Euphorbia heterophylla*	Euphorbiaceae	88.9	36.4	44.5	36.2	72.6
5.	*Kyllinga erecta*	Cyperaceae	22.2	9.1	11.1	9.1	18.2

6.	*Vicia sativa*	Fabaceae	11.1	4.5	5.6	4.5	18.2
7.	*Pennisetum purpureum*	Poaceae	22.2	9.1	11.1	9.1	18.2
	Total		**244.3**	**100**	**122.3**	**100**	**200**
5-10 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	44.4	3.3	22.2	33.2	66.5
2.	*Eleusine indica*	Poaceae	22.2	16.7	11.1	16.6	33.3
3.	*Kyllinga erecta*	Cyperaceae	22.2	16.7	11.1	16.6	33.3
4.	*Mimosa pudica*	Mimosaceae	11.1	8.3	5.6	8.3	16.6
5.	*Sida acuta*	Malvaceae	33.3	25.0	16.7	8.3	16.6
	Total		**133.2**	**100**	**66.7**	**100**	**200**
10-15 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	11.1	20.0	5.6	20.1	40.1
2.	*Kyllinga erecta*	Cyperaceae	11.1	20.0	5.6	20.1	40.1
3.	*Mimosa pudica*	Mimosaceae	22.2	40.0	11.1	40.2	80.0
4.	*Sida acuta*	Malvaceae	11.1	20.0	5.6	20.1	40.1
	Total		**55.5**	**100**	**27.9**	**100**	**200.3**

Table 2: Species Abundance of Site A Point 2

0-5 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Ageratum conyzoides*	Asteraceae	11.1	11.7	11.1	11.7	23.4
2.	*Carex pendula*	Cyperaceae	16.7	17.7	16.7	17.7	35.4
3.	*Commelina diffusa*	Commelinaceae	5.6	5.9	5.6	5.9	11.8
4.	*Euphorbia heterophylla*	Euphorbiaceae	22.2	23.4	22.2	23.4	46.8
5.	*Kyllinga erecta*	Cyperaceae	5.6	5.9	5.6	5.9	11.8
6.	*Vicia sativa*	Fabaceae	11.1	11.7	11.1	11.7	23.4
7.	*Pennisetum purpureum*	Poaceae	22.2	23.4	22.2	23.4	46.8
	Total		**94.5**	**100**	**95.0**	**100**	**200**
5-10 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	22.2	22.1	11.1	22.2	43.3
2.	*Eleusine indica*	Poaceae	11.1	11.2	5.6	11.1	22.1
3.	*Kyllinga erecta*	Cyperaceae	22.2	22.1	11.1	22.2	43.3
4.	*Mimosa pudica*	Mimosaceae	11.1	11.0	5.6	11.1	22.1
5.	*Sida acuta*	Malvaceae	33.3	33.3	16.7	33.3	66.6
	Total		**99.9**	**99.7**	**50.1**	**99.8**	**199.5**
10-15 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	11.1	50.0	5.6	50.0	100
2.	*Mimosa pudica*	Mimosaceae	11.1	50.0	5.6	50.0	100
	Total		**22.2**	**100**	**11.2**	**100**	**200**

Table 3: Species Abundance of Site B Point 1

0-5cm depth

S/N	Species		Species density (m^{-2})	Relative density	Frequency	Relative frequency	Importance value
1.	*Amaranthus retrofluxus*	Amaranthaceae	11.1	4.4	4.6	4.4	8.8
2.	*Amphicarpaea bracteata*	Fabaceae	33.3	13.0	16.7	13.1	26.1
3.	*Capsicum annum*	Solanaceae	44.4	17.4	22.2	17.4	34.8
4.	*Chromolena odorata*	Asteraceae	33.3	13.0	16.7	13.1	26.1
5.	*Commelina diffusa*	Commelinaceae	22.2	8.7	11.1	8.7	17.4
6.	*Pennisetum purpureum*	Poaceae	55.6	21.8	27.8	21.8	43.6
7.	*Euphorbia heterophylla*	Euphorbiaceae	11.1	4.4	5.6	4.4	8.8
8.	*Mimosa pudica*	Mimosaceae	22.2	8.7	11.1	8.7	17.4
9.	*Physalis angulata*	Solanaceae	22.2	8.7	11.1	8.7	17.4
	Total		**255.4**	**100**	**127.9**	**100**	**200**
5-10cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Amphicarpaea bracteata*	Fabaceae	11.1	7.7	5.6	7.8	15.5
2.	*Chromolena odorata*	Asteraceae	44.4	30.8	22.2	30.8	61.6
3.	*Kyllinga erecta*	Cyperaceae	22.2	15.4	11.1	15.4	30.8
4.	*Euphorbia heterophylla*	Euphorbiaceae	22.2	15.4	11.1	15.4	30.8
5.	*Talinum triangulare*	Portulacaceae	33.3	23.1	16.7	23.1	46.2
6.	*Physalis angulata*	Solanaceae	11.1	7.7	5.6	7.8	15.5
	Total		**144.3**	**100**	**72.3**	**100**	**200**
10-15 cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Cynodon dactylon*	Poaceae	22.2	50.0	11.1	50.0	100
2.	*Physalis angulata*	Solanaceae	11.1	25.0	5.6	25.0	50.0
3.	*Sida acuta*	Malvaceae	11.1	25.0	5.6	25.0	50.0
	Total		**44.4**	**100**	**22.2**	**100**	**200**

Table 4: Species Abundance of Site B Point 2

0-5cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Amaranthus spinosus*	Amaranthaceae	22.2	11.1	11.1	11.1	22.2
2.	*Chromolena odorata*	Asteraceae	33.3	16.7	16.7	16.7	33.4
3.	*Commelina diffusa*	Commelinaceae	11.1	5.6	5.6	5.6	11.2
4.	*Eleusine indica*	Poaceae	33.3	16.7	16.7	16.7	33.4
5.	*Pennisetum purpureum*	Poaceae	44.4	22.2	22.2	22.2	44.4
6.	*Melothria pendula*	Cucurbitaceae	22.2	11.1	11.1	11.1	22.2
7.	*Phalaris arundinacea*	Poaceae	11.1	5.6	5.6	5.6	11.2
8.	*Solanum americanum*	Solanaceae	22.2	11.1	11.1	11.1	22.2
	Total		**199.8**	**100**	**100**	**100**	**200**

5-10cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Commelina diffusa*	Commelinaceae	22.2	40.0	11.1	40.0	80.0
2.	*Eleusine indica*	Poaceae	11.1	20.0	5.6	20.0	40.0
3.	*Melothria pendula*	Cucurbitaceae	22.2	40.0	11.1	40.0	80.0
	Total		**55.5**	**100**	**27.8**	**100**	**200**
10-15cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Kyllinga erecta*	Cyperaceae	22.2	50.0	11.1	50.0	100
2.	*Physalis angulata*	Solanaceae	22.2	50.0	11.1	50.0	100
	Total		**44.4**	**100**	**22.2**	**100**	**200**

Table 5: Species Abundance of Site C Point 1

0-5cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	33.3	12.5	16.7	12.5	25.0
2.	*Commelina diffusa*	Commelinaceae	33.3	12.5	16.7	12.5	25.0
3.	*Cyperus rotundus*	Cyperaceae	11.1	4.2	5.6	4.2	8.4
4.	*Euphorbia heterophylla*	Euphorbiaceae	11.1	4.2	5.6	4.2	8.4
5.	*Laportea aestuans*	Urticaceae	11.1	4.2	5.6	4.2	8.4
6.	*Phalaris arundinacea*	Poaceae	22.2	8.3	11.1	8.3	16.6
7.	*Setaria pumila*	Poaceae	44.4	16.7	22.2	16.7	33.4
8.	*Synderella nodiflora*	Asteraceae	66.7	25.0	33.4	25.0	50.0
9.	*Talinum triangulare*	Portulacaceae	11.2	4.2	5.6	4.2	8.4
10.	*Tridax procumbens*	Asteraceae	22.2	8.3	11.1	8.3	16.6
	Total		**266.5**	**100**	**133.3**	**100**	**200**
5-10cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Cyperus rotundus*	Cyperaceae	22.2	16.7	11.1	16.7	33.4
2.	*Euphorbia heterophylla*	Euphorbiaceae	33.3	25.0	16.7	25.0	50.0
3.	*Phalaris arundinacea*	Poaceae	11.1	8.3	5.6	8.3	16.6
4.	*Setaria pumila*	Poaceae	33.3	25.0	16.7	25.0	50.0
5.	*Synderella nodiflora*	Asteraceae	11.1	8.3	5.6	8.3	16.6
6.	*Physalis angulata*	Solanaceae	22.2	16.7	11.1	16.7	33.4
	Total		**133.2**	**100**	**65.1**	**100**	**200**
10-15cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Kyllinga erecta*	Cyperaceae	11.1	33.3	5.6	33.3	66.6
2.	*Mimosa pudica*	Mimosaceae	11.1	33.3	5.6	33.3	66.6
3.	*Physalis angulata*	Solanaceae	11.1	33.3	5.6	33.3	66.6
	Total		**33.3**	**99.9**	**16.8**	**99.9**	**199.8**

Table 6: Species Abundance of Site C point 2

0-5cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Carex pendula*	Cyperaceae	11.1	9.1	5.6	9.1	18.2

2.	*Commelina diffusa*	Commelinaceae	11.1	9.1	5.6	9.1	18.2
3.	*Cyperus rotundus*	Cyperaceae	11.1	9.1	5.6	9.1	18.2
4.	*Euphorbia heterophylla*	Euphorbiaceae	22.2	18.2	11.1	18.1	36.4
5.	*Laportea aestuans*	Urticaceae	22.2	18.2	11.1	18.2	36.4
6.	*Synderella nodiflora*	Asteraceae	11.1	9.1	5.6	9.1	18.2
7.	*Tridax procumbens*	Asteraceae	33.3	27.3	16.7	27.3	54.6
	Total		**122.1**	**100**	**61.1**	**100**	**200**
5-10cm depth							
S/N	**Species**		**Species density (m^{-2})**	**Relative density**	**Frequency**	**Relative frequency**	**Importance value**
1.	*Cyperus rotundus*	Cyperaceae	11.1	33.4	5.6	33.4	66.8
2.	*Euphorbia heterophylla*	Euphorbiaceae	22.2	66.6	11.1	66.6	134.2
	Total		**33.3**	**100**	**16.7**	**100**	**200**

Table 7: Shannon Weiner Seed Bank Diversity Index for Sites at Different Points and Depths in the Study Area

Community Type	**Total Number of Emergence**	**H^1**	**H max**	**Equitability index**
Site A point 1 at 0-5 cm depth	22	1.196	1.485	0.884
Site A point 1 at 5-10 cm depth	12	0.625	1.197	0.740
Site A point 1 at 10-15 cm depth	5	0.782	1.079	0.857
Site A point 2 at 0-5 cm depth	17	1.012	1.565	0.785
Site A point 2 at 5-10 cm depth	9	0.838	1.485	0.740
Site A point 2 at 10-15 cm depth	2	0.831	1.398	0.764
Site B point 1 at 0-5 cm depth	24	2.136	1.398	0.891
Site B point 1 at 5-10 cm depth	13	1.083	1.485	0.838
Site B point 1 at 10-15 cm depth	4	0.059	0.386	0.764
Site B point 2 at 0-5 cm depth	18	0.594	1.609	0.991
Site B point 2 5-10 cm depth	5	0.689	0.693	0.994
Site B point 2 at 10-15 cm depth	4	0.898	0.099	0.817
Site C point 1 at 0-5 cm depth	24	2.314	1.386	0.948
Site C point 1 at 5-10 cm depth	12	0.637	0.693	0.918
Site C point 1 at 10-15 cm depth	3	0.898	0.099	0.817
Site C point 2 at 0-5 cm depth	11	1.514	1.386	0.948
Site C point 2 at 5-10 cm depth	3	0.637	0.693	0.922
Site C point 2 at 10-15 cm depth	-	-	-	-

4. Discussion

A total of (25) species of plants were identified within 13 families, they include: Asteraceae, Cyperaceae, Commelinaceae, Euphorbiaceae, Fabaceae, Poaceae, Mimosaceae, Malvaceae, Amaranthaceae, Solanaceae, Portulacaceae, Cucurbitaceae and Urticaceae.

In the study area, the families Fabaceae, Amaranthaceae and Solanaceae had 2 species each; Euphorbiaceae, Mimosaceae, Malvaceae, Portulacaceae, Cucurbitaceae, Urticaceae and Commelinaceae all had 1 species each. A total of five families were recorded for grasses while Asteraceae family had four species. The family Poaceae had the highest number, 5 species and the family Cyperaceae had 3 species. From the above results, the families that had the most common herb species were Poaceae, Asteraceae and Cyperaceae. The Poaceae family is known to be one of the most widely distributed and abundant plant group, as well as an important family of the earth's flora [9]; they thrive because they have high tolerance for grazing herbivores and fire, they exhibit varied means of reproduction, and they've shown versatility in their photosynthetic process.

A total of 187 plants germinated from the soil samples collected in the study area. There were 67 plants that germinated from site A which is at the back of bioscience faculty building, 68growths from site B at agriculture faculty and 52 growths from site C behind botany laboratory. 10species were identified from point 1 of site A and 9species from point 2 of the same site A. 13species were identified from point 1and 10 species from point 2 of the site B. 10 species were identified from point 1 of site C and 10 species from point 2.

The species encountered include; *Ageratum conizoides, Amaranthus blium, Amaranthus spinosus, Amphicarpaea bracteata, Carex pendula, Capsicum annum, Chromolena odorata, Commelina diffusa, Cynodon dactylon, Cyperus rotundus, Eleusine indica, Euphorbia heterophylla, Laportea aestuans, Luffa acutangula, Melothria pendula, Mimosa pudica, Phalaris arundinacea, Phyllantus urinaria, Physalis angulate, Setaria pumila, Sida acuta Solanum americanum, Synedrella nodiflora. Euphorbia heterophylla* has the highest density in the study site A (behind faculty of biosciences building science village). *Pennisetum purpureum* is has the greatest density in the study site B (behind agriculture faculty) and *Synedrella nodiflora* has the highest density in study site C.

Table 1 showed the species abundance of site A point 1 in the study area. At 0-5 cm depth, a total of 7 plant species from 6 different families were observed, *Euphorbia heterophylla* of family Euphorbiaceae had the highest species density of $88.9m^{-2}$, the highest relative density and frequency of 36.4 and 44.5 respectively as well as the highest relative density and importance value of 36.2 and 72.6 respectively; The high values could probably be because of the presence of seeds that could easily be dispersed together with their rapid regeneration abilities, but unfortunately, at depths of 5-10 cm and 10-15 cm, the *E. heterphylla* was conspicuously absent even with the high figures observed in 0-5 cm depths, which could also mean that due to the ease of dispersal of these seeds, they were easily washed off or carried away, thus, its inability to sink into the soil and form part of the soil seed bank. *Kyllinga erecta* and *Carex pendula* were both seen in all the depths of site A point 1; although their species density and relative density were higher at 0-5 cm and 5-10 cm depths, likewise their frequency, relative frequency and importance value. *Ageratum conyzoides* of family Asteraceae, *Pennisetum purpureum* of Poaceae family, *Vicia sativa* of Fabaceae family and *Commelina diffusa* of Commelinaceae family were all present in 0-5 cm depth but were not seen in other depths; this simply means that these plant species do not have a strong presence in this site as their seeds did not form part of the seed bank of the soil in this site. More so, *Eleusine indica* of the Poaceae family was only seen in 5-10 cm depth, while *Mimosa pudica* of Mimosaceae family and *Sida acuta* of Malvaceae family were only present in 5-10 cm and 10-15cm depths. However, this study reveals that seed banks may facilitate the coexistence of potentially competing species and mitigate the effects of inter-specific and intra-specific competition. In agro ecosystems, the soil seed bank is closely related to weed studies; most of the seeds in the seed bank come from the nearby parent plants, while the remaining seeds are contributed by plant communities along distance away from the parent plant.

The species abundance for site A point 2 was shown in table 2. The species presence were the same with site A point 1 but the values for the species density, relative density, frequency and relative frequency as well as importance value were significantly lower than that of site A point 1. *E. heterophylla* also had a higher value just like in site A point 1, although it tied with *P. purpureum* in having the same figures. The numbers of *C. diffusa* and *K. erecta* were quite very low at the 0-5 cm depth. *C. pendula* was the only species present in all depths at point 2 in site A just like it was in point 1.

Tables 3 and 4 showed the species abundance of site B in points 1 and 2 of the study area. *Physalis angulata* of family Solanaceae was seen in all depths at point 1, while in point 2 it was only seen in 10-15 cm depth. Also, *Amphicarpaea bracteata* of family Fabaceae, *Chromolena odorata* of family Asteraceae and *Euphorbia heterophylla* of the Euphorbiaceae family were all present in 5-10 cm and 10-15 cm depths at point 1; *Commelina diffusa* of family Commelinaceae, *Eleusine indica* of the Poaceae family and *Melothria pendula* of family Cucurbitaceae were all present in 0-5 and 5-10 cm depths at point 2. *C. odorata, C. diffusa, P. purpureum and K. erecta* are the only plants that were common to points in site B; although, point 1 showed a higher total species density and as such had more species abundance than point 2. This could be as a result of point 1 having more deposits of seed either from the flow of the water body or from the movement of animals; studies have shown that herbivours play a key role in the dispersal of seeds [10] and enhancing local colonization processes and plant diversity [11].

Tables 5 and 6 showed the species abundance in site C points 1 and 2 respectively. In this site, there was more species abundance, with a total species density of over 588 m^2 in all depths at the two points. More so, there were more species found on site C, as the site even had more species diversity when compared with other sites in the

study area. This result corroborates with the findings of Ekwealor et al. [12] who reported that about half the species identified in the forests across Nnamdi Azikiwe University, were found at soil depth of 0-5 cm while slightly above one-third of species identified were found at soil depth of 6-10cm. less than 20% of total species identified were found at soil depth of 11-15 cm.

From the results gotten from different sites, a good number of plant species showed very high Importance Value Index (IVI) of nothing less than (50%). The plant species *Euphorbia heterophylla* (72.6%) had the highest IVI in site A point 1, while *Carex pedula* and *Mimosa pudica* at site A point 2 had IVI of (100%) each. The plant species *Cynodon dactylon* had the highest IVI of (100%) at site B point 1 while *Kyllinga erecta* and *Physalis angulata* had IVI of (100%) each recorded for site B point 2. Also, in site C point 1, *Kyllinga erecta*, *Mimosa pudica* and *Physalis angulata* all had equal IVI of (66.6%), while *Euphorbia heterophylla* record the highest value of IVI (134.2%) for site C point 2 and for all the sites in the area studied. Generally, the importance value which is also the importance percentage of a species, gives an all-inclusive estimate of the impact and importance of a plant species in the community. The IVI is critical at putting a comparison on the ecological significance of species and it also indicates the level of dominance of a species in the vegetative structure of an area [13], [14]. In addition, IVI plays a practicable measure in assessing the overall importance of a species since it considers several properties of the species in the vegetation. The importance value indices IVI of the plant species were generally high in the study area. The high IVI values could be due to different species represented by a good number of individuals for each plant species. This is not consistent with the works of Abdullahi [15] who observed that the importance value indices IVI of the herbaceous species in his study area were generally low due to different species with few individuals represented in each herbaceous species.

The results of Shannon- Weiner index of Diversity for the study area was higher in site A point 1 at 0-5 cm depth (1.196), site B point 1 at 0-5 cm depth (2.136) and site C point 1 at 0-5 cm depth (2.314). The high values were an indication of a more complex and healthy community which possess greater variety of species and invariably allows for more species interactions [16]. This will likely bring about better stability in ecosystem, and depict a good environmental condition. The high diversity could also be as a result of the high soil fertility brought about by deposits from the flowing stream.

A similar study was carried out on the Shannon-Wiener Index of diversity (H') where it was reported by Richard et al. [17] to be 4.27 for the Miombo Woodlands of Bereku Forest Reserve and 2.76 in Khadimnagar National Park of Bangladesh; although the value of 1.196, 2.136 and 2.314 as well as other H^1 values from the study area are all lower than the 4.27 and 2.76 reported by the aforementioned researchers.

Conclusion

In conclusion, the results of this study portends a great deal of soil seed bank potentials as the soil seed bank of the study area showed a wide range of species diversity and abundance. Studies have shown that seed bank plays a critical role in vegetation maintenance, succession, ecosystem restoration, differential species management and conservation of genetic variability. Thus, this study supports the well known fact that soil seed banks, which are considered to be a potential vegetation community, can facilitate the renewal and succession of vegetation. Soil seed bank have been applied widely in vegetation restoration projects.

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