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DIVERSITY AND COMPOSITION OF SOIL SEED BANKS IN SELECTED MAIN ROADSIDES IN PORT HARCOURT METROPOLIS, NIGERIA

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ABSTRACT

Soil seed banks consist of viable seeds in the soil that have the ability of resorting adult plants. Its role is very vital in ecosystem. To species diversity in soil seed banks of four major roadsides (Aba Road, East/West Road, Ikwerre Road and NTA Road) in Obio/Akpor Local Government Area and a control (Ikwerrengwo) in Etche Local Government Area in Port Harcourt, Rivers State, Nigeria. Soil samples were obtained using systematic sampling technique at different soil depths (0-5 cm, 5-10 cm and 10-15 cm) with the aid of a soil auger. Seedling emergence method was employed in analyzing the soil seed bank. Shannon-Weiner diversity index was used to determine the species diversity and evenness. A total number of twenty five species belonging to fourteen families were identified from the soil seed banks. Species such as *Oldenlandia* species, *Agerantum comyzoides*, *Pennisetum* species, *Elusine indica*, *Talinum triangulare* and *Mimosa* species were common at both the experimental and control sites. The soil seed banks studied revealed that the experimental and control sites were characterized by more grasses, more herbs and fewer trees and shrub. The number of species at the control site were more than the experimental sites. Thus, vehicular emission and man's disturbance of roadside soils has changed the diversity and composition of roadside soils.

Keywords: Soil Seed Bank, Metropolitan roads, Ruderals, Species Diversity, Species composition.

INTRODUCTION

Heavy metal pollution is one of the major environmental problems in today's world. It is of great interest to researchers because of its harmful effects to plants and invariably to animals and humans that consume them. Heavy metals can be defined as members of loosely defined subset of elements exhibiting metallic properties. They include some metalloids, transition metals, some actinides and lanthanides. They may include elements that are lighter than carbon and may exclude some heaviest metals. They occur naturally in our ecosystem with variations in their concentration.

The quest for urbanization and industrialization has led to a lot of anthropogenic activities which results to the increase in concentration of these metals to amounts that are harmful to both plants and animals. These activities include; municipal waste disposal, burning of fossil fuels, sewage sludge, waste-derived fuels, the use of fertilizers and pesticides in agriculture (Alloway, 1990; Raskin *et al.*, 1994; Shen *et al.*, 2002). High concentration of certain heavy metals such as Cd, Cr, Cu, Ni and Zn in soil disrupts the innate terrestrial and aquatic ecosystems (Gardea-Torresday *et al.*, 1996; Meagher, 2000). Elevated level of heavy metals in soil result in decrease in the growth rate of plants and it disturbs mainly the plants cellular redox environment which results to oxidative stress in the leaves and roots of plants (Tamas *et al.*, 2008). Some of these heavy metals are very essential for plant growth at low concentration but at higher concentration may result in growth inhibition and metabolic disorders for some plant species (Fernandes and Henriques, 1991). Poisonous effects of heavy metals differ greatly among different plants (Leon *et al.*, 2002).

Seed bank plays vital roles in plant communities. Soil seed banks comprise of seeds that are viable in the soil that has the potential capabilities of replacing adult plants (Thompson and Grime, 1979; Baker, 1989). Most of the seeds in the seed bank come from nearby parent plantswhile others are contributed by the communities of plants along some distance away from the parent plants (Solomon, 2011). Two main seed bank exist; transient types in which no seed remain viable for more than one year and persistent types in which seeds remain viable for more than one year (Thompson and Grime, 1979). Critical roles played by soil seed banks in the ecosystem include; differential species management, vegetation maintenance, ecosystem restoration, conservation of genetic variability and succession (Hills and Morris, 1992).

Roadside soils contain high concentration of heavy metals released from the wear and tear of automobile tyres, corrosion of car metal parts, oil leakage and burning of fuel (Dolan *et al.*, 2006). The toxicity of heavy metals in soil is a problem of increasing significance for ecological, nutritional and environmental reasons and these heavy metals are non-degradable. Thus, the aim of this study is to evaluate the effects of vehicular emission on the soil seed bank of some major roadsides.

2.0 MATERIALS AND METHODS

2.1 Description of the Study Area.

This study was conducted along four busy roadside (East/West Road, Ikwerre Road, Aba Road and NTA Road) in parts of Obio/Akpor Local Government Area and the control in Ozuguru in Ikwerrengwo in Etche Local Government Area both in Rivers State Nigeria. The roads sampled are geographically located between latitude 4.891N to latitude 4.908N and longitude 6.902E to longitude 6.928E. The map of sampling area is presented in Figure 1. The study area experiences rainy and dry seasons. Rainy season starts from April and ends in October while dry season starts from November and ends in March. The climatic features of the study area include; high sunshine, high temperature, high relative humidity and high rainfall. The mean annual rainfall and temperature for 2015 were 134.5mm and 27.15^0C respectively (The Nigeria Meteorological Agency, 2016).

The nutrient content of the soil is usually low which is as a result of severe rainfall that leaches nutrients down the soil profile (Eludoyin *et al.*, 2011). Aba Road and East/West Road are among the major roads in Rivers State that links parts of Northern, Eastern and Western States with Rivers State, this results to a lot of traffic and exhaust fumes that emanate from both heavy duty and smaller vehicles are experienced along these roads. NTA Road and Ikwerre Road also experience heavy vehicular movement but of less traffic consequences when compared with the earlier two. Ozuguru in Ikwerrengwo (the control site) is a rural area and the residents there are mostly peasant farmers.

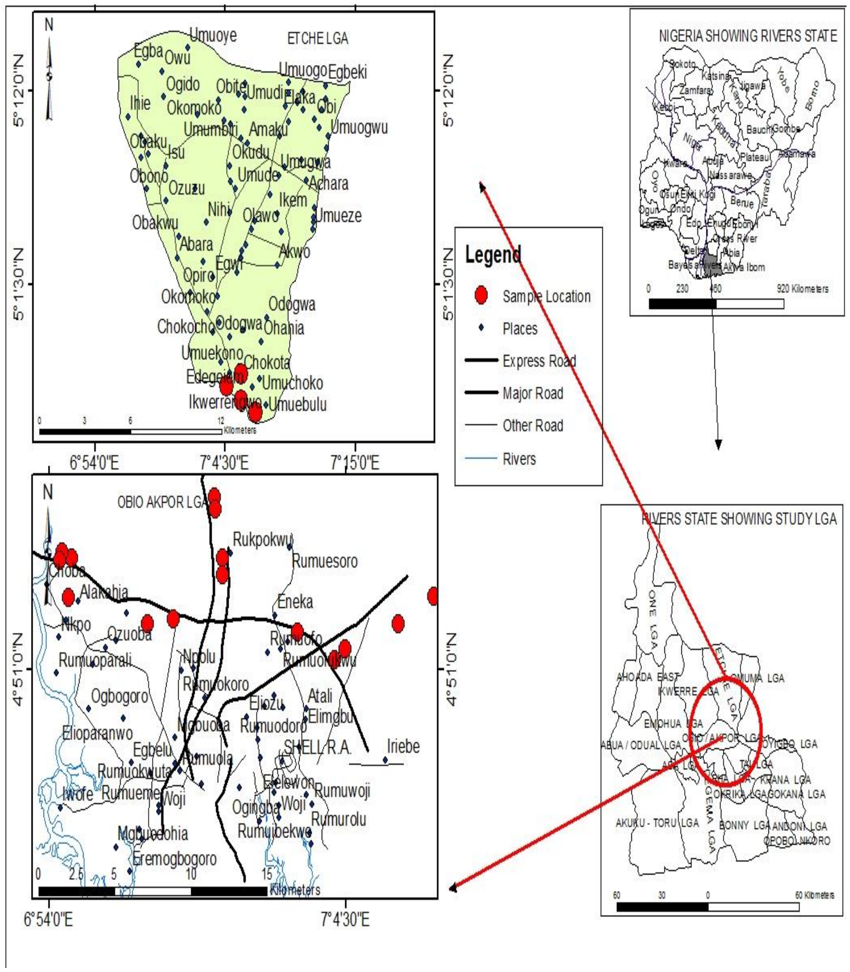

Figure 1: Map of sampling area showing the different sample collection at both the experimental and the control sites

Sample Collection

Sampling and field data gathering were carried out during dry season in the months of February and March, 2019. The sample collection was done between the hours of 6.30a.m and 11a.m. Four sampling points were established along each of the experimental and control sites within a minimum distance of one kilometer each. At each sample point, three soil depths (0-5cm, 5-10cm and 10-15cm), they were collected with the aid of soil auger at a distance of one metre away from the edge of the road. The soils from each sample point were mixed thoroughly to form a composite sample and were transferred immediately into different sterile polyethene bags to prevent contamination from other sources, labeled with an indelible marker pen and were transferred quickly to the centre of Ecological Studies, University of Port Harcourt to determine the seed bank of the soil using seedling emergence method. A total of 60 soil samples were collected from both the experimental and the control sites.

The soils were sieved through a 2mm sieve to remove soil debris that were present in the soil, 100 grams from each sieved soil were put in a well labeled perforated bowl with a good diameter to give a thickness of 1 centimeter. The perforations at the bottom of the bowls were covered with Whatman filter paper No. 45 that prevented the soil from going out through the perforation. Each soil depth from each experimental site had three replicates making a total of one hundred and eighty bowls including the control group. The soils in the perforated bowls were watered daily, exposed to sunlight during the day and were covered with a transparent board whenever it wants to rain to prevent loss of weed seeds that might occur due to rain splash.

The soil were observed daily, two days after initial watering of the soil, seedlings started emerging. The seedlings were identified and counted weekly by a plant taxonomist after which they were carefully uprooted with the aid of a spatula and were discarded while the experimental and control soils were watered daily. At the end of every two weeks intervals, after the seedling identifications and uprooting of the germinated seedlings, the soil in each bowl were turned and homogenized while the old Whatmann filter paper were removed and replaced with new ones with the same soil back to the same bowl. This was done for six weeks (compressed seed bank) before discarding the soil.

RESULTS

The results of the number of plant family, species, diversity and evenness at the experimental and control site is presented in Table 1. A total of 25 species belonging to 14 families were identified at the above ground vegetation. These include 17 annuals and 8 perennials. The result showed the different types of plant species, their families, the number of individual species, species diversity and evenness.

The total number of species found at Aba Road soil were 17 species, East/West Road had 19 species, Ikwerre Road had 15 species, NTA Road had 18 species and the control site had 22 species. This indicates that the control site had the highest species diversity. The diversity at the control and experimental sites were in this order; control site> Ikwerre Road > Aba Road > NTA Road > East/West Road.

The dominant species at Aba Road were *Oldenlandia species* and *Pennisetum species* and the sparsely present species were *Solenostemon monotachy* and *Aspilia africana.* In East/West Road, the dominant species were *Oldenlandia species, Agerantum comyzoides* and *Pennisetum species* while sparsely present species were *Alterandhera species, Cynodon dactylon* and *Echinochloa species.*

The dominant species at Ikwerre Road were *Agerantum comyzoides, Oldenlandia species* and *Eleusine indica* while sparsely present species were *Paspalum species, Alterandhera species* and broad leaves. At NTA Road, the most dominant species were *Oldenlandia species, Ageranthum comyzoides* and *Cynidin dactylon* while sparsely present species were *Panicum maximum, Solenostemon monotachy* and *Echinochloa species.* At the control site, the most dominant species were *Agerantum comyzoides, Alterandhera species* and *Digitaria species* while sparsely present species were *Carex appressa, Boerhavia species,* and *Dactyloctinum aegyptium.*Ikwerre road had the highest evenness while East/West road had the least.

It was observed that *Oldenlandia species, Agerantum comyzoides, Pennisetum species, Elusine indica, Talinum triangulare* and *Mimosa species* were common at both the experimental and control sites. The soil seed bank studied revealed that the experimental and control sites were characterized by more grasses, more herbs and fewer trees and shrub.

Table 1: Seedling Emergence from the Soil Seed Bank of roadsides in Port Harcourt metropolis, River State, Nigeria

S/N	Plant Species	Family	Plant Form	Aba Road	East/West Road	Ikwerre Road	NTA Road	Control Site
1	*Oldenlandia species*	Rubiaceae	Herb	142	82	16	70	14
2	*Agerantum comyzoides*	Asteraceae	Herb	49	79	22	21	34
3	*Carex appressa*	Cyperaceae	Grasses	0	5	0	6	1
4	*Paspalum species*	Poaceae	Grasses	22	20	1	9	0
5	*Eleusine indica*	Poaceae	Grasses	18	8	12	5	4
6	*Talinum triangulare*	Portulacaceae	Herb	12	5	5	4	2
7	*Mimosa species*	Fabaceae	Tree	22	19	7	5	6
8	*Phyllanthus species*	Phyllanthaceae	Tree	11	12	8	14	0
9	*Acalypha species*	Euphorbiaceae	Shrub	0	2	2	4	2
10	*Alterandhera species*	Amaranthaceae	Grasses	0	1	1	9	20
11	*Cynodon dactylon*	Poaceae	Grasses	31	1	2	16	8
12	*Digitaria species*	Poaceae	Grasses	0	6	0	0	17
13	*Aspilia Africana*	Asteraceae	Herb	3	0	3	4	10
14	*Lindernia species*	Linderniaceae	Grasses	41	0	0	3	16
15	*Axonopus compresus*	Poaceae	Grasses	11	8	2	0	9
16	*Pennisetum species*	Poaceae	Grasses	92	62	8	13	16
17	*Boerhavia species*	Nyctagineaceae	Herb	0	6	0	0	1
18	*Amaranthus species*	Amaranthaceae	Herb	8	3	2	0	3
19	*Echinochloa species*	Poaceae	Grasses	0	1	0	1	2
20	*Schwenckia americana*	Solanaceae	Grasses	0	0	0	0	2
21	*Portulaca species*	Portulacaceae	Herb	4	0	0	2	0
22	*Solenostemon monotachy*	Lamiaceae	Tree	2	0	0	1	3
23	*Panicum maximum*	Poaceae	Grasses	10	2	2	1	3
24	*Broad leaves*	Plantaginaceae	Herbs	16	11	1	2	7
25	*Dactyloctinum aegyptium*	Poaceae	Grasses	0	0	0	0	1
	No. of species			**17**	**19**	**15**	**18**	**22**
	No. of individuals			**494**	**333**	**246**	**190**	**181**
	Species Diversity			**2.287**	**2.008**	**2.362**	**2.096**	**2.637**
	Species Evenness			**0.13**	**0.11**	**0.16**	**0.12**	**0.12**

DISCUSSION

The contaminations of soil by heavy metals result in different adverse effects on the growth of plants. These include poor physical structure, reduction in micro nutrients, alkalinity, concentration of toxic metals etc (Bradshaw and Chadwick, 1982). Result obtained from the soil seed bank studied revealed different plant communities at both the experimental and control sites. From the result, it was observed that the soil from the control site had more grasses from different families than the experimental sites. The reduction in the number of grasses at the experimental sites could be attributed to different contaminants that emanate from different diffuse and point sources that settle on the soil thereby suffocating plants and soil microbes since soil are major terrestrial sink for pollution. This is in line with Giller *et al.* (1998) who reported that metal contamination result in poor plant yield and quality and changes the activities and composition of soil microbes. Yao *et al.* (2003) showed the adverse effect of heavy metals on soil microbial community. Also, Kandeler *et al.* (1996) reported reduction in the diversity of functional microbial communities due to heavy metals. From the result, it was also observed that the number of trees identified from the soil seed bank studied were more from the control site than the experimental sites. This concurs with the findings made by Yao *et al.* (2003) that heavy metals cause great reduction in species diversity of soil microbial communities. It was observed that *Schwenckia americana* was only identified in the soil from the control site. This agrees with Shu *et al.* (2002) who reported that heavy metals might cause serious phytotoxic effects and could act as a propelling force in the change of tolerant population. Also, the control site had the highest diversity index calculated. Yao *et al.* (2006) also observed reduction in population diversity of microbial communities in a Cu polluted red soil. Also, Kandeler *et al.* (1996) reported reduction in the diversity of functional microbial communities due to heavy metals.

From the result, it was observed that there was reduction in species diversity at the experimental sites than the control site which could be due to the increase in heavy metal pollution at the experimental sites.

CONCLUSION

The soil seed bank studied showed that the seed bank were of persistent type. Studies on soil seed bank help in the identification of qualitative and quantitative determination of viable seeds that were buried beneath the soil. As a major component in vegetative dynamics, it plays vital roles in ecosystem restoration, succession, vegetative maintenance and conservation of genetic variability and the management of differential species. It also brings to the knowledge of researchers the types of seeds that are present in a particular soil.

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