Nigerian Journal of Ecology (2022) 18(2): 62-74

ISSN: 1116-753X

Assessment of Soil Seed Bank Flora of Selected Metal Dumpsites in Rivers State, Nigeria

[1]Ochekwu, E.B. and Anyanwu, F. U.
Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Port Harcourt, Nigeria
[1]Corresponding Author's E-mail: edacheb@gmail.com

(Accepted 17 December, 2022)

ABSTRACT

Soil seed bank of three scrap metal dumpsites were assessed for weed composition in River State Nigeria. Soil samples were acquired from nine locations in the three communities comprising studied; six scrap metal dumpsites and three control sites at three varying depths (0-5cm, 5-10cm and 10-15cm plates, each containing 100g soil were cultured and monitored for seedling emergence, species composition and abundance for 12 weeks. Soil physical and chemical properties and heavy metal (copper, zinc and lead) composition of soil samples were determined following standard procedures Result were statistically analysed using ANOVA at P=0.05. The results shows that control site had the highest number of emergent seedling and was significantly different P<0.05 from the scrap metal sites at all depts except in Aluu scrap metal at 10-15cm. Control had the highest weed seed population particularly at 0-5cm depth. Copper, zinc and lead were present at all scrap metal sites. Consequently, the scrap metal had potential detrimental effects on the soil seed bank population in all the locations assessed.

Key words: Weed population; soil seed bank; metal scrap; Dump sites; Heavy metals

INTRODUCTION

The relevance of soil seed bank studies has gained grounds in many countries: Moore, (1980) expressed that seed bank is compared to a current and store account in a bank, and the term 'seed bank' was always utilized for this inert plant network in the '70s. Soil seed bank is essential in plantation renovation reclamation, biological diversity conservation, vegetation progression, dispersion forms and different aspects, the investigation on soil seed banks have attracted an enormous range of interest (Li *et al*., 2009). According to Roberts (1981), the term soil seed bank describes the viable seed reservoir accessible in a soil. For Baker (1989), this reservoir is like the seeds not germinated but capable of supplanting the annual adult plants, which had disappeared by natural death or not, and perennial plants that are probably going to be affected by plant diseases, disturbance and animal consumption, including man. According to Simpson *et al*. (1989), soil seed bank encompasses all the accessible seeds in the soil or mixed to soil debris that are fit for surviving and thriving. Two methods are utilized in the examination/determination of soil seed banks and recovery. This involves either collecting a sample of the seed itself and undertaking an identification process (physical separation methods) which is also called manual seed extraction or growing the seed itself and identifying the seedlings thereafter (seedling emergence) (INHF, 2001, Anyanwu *et al*., 2019). The common methods are seed flotation in oversaturated salt solutions (Tsuyuzaki, 1994) and sample sieving (Roberts, 1981); then, extracted seeds are identified under a binocular microscope. Two methods are utilized in the examination of soil seed banks and recovery. The other methods involves seedling emergence (INHF, 2001, Anyanwu, *et al.,* 2019). The seedling emergence method involves the placement of soil samples under suitable conditions for seed germination (i.e., greenhouse or germination chamber); then, the emerging seedlings are identified and counted (Thompson and Grime 1979). The seedling emergence method is less relentless and helpful for a huge volume of soil tests (Plue *et al*., 2012).

The adequacy of seed extraction and seedling emergence techniques for assessing seed density and composition of soil seed banks was identified with explicit germination necessities, seed dormancy and seed size and mass. Studies on soil seed banks have gained immense interest due to their importance in the ecological restoration and vegetation succession (Ochekwu *et al.,* 2022). High errors between these techniques confine the probability of making speculations. Gonzalez and Ghermandi, (2012) proffered that the methods to be adopted should be dictated by the point of examination. Despite the constraints of the seed extraction technique, it might be favoured over the seedling emergence technique for research which centres around deciding the seedbank of a subset of expansive seeded species or when quick information is wanted. Furthermore, Gonzalez and Ghermandi, (2012) proposed that in explaining the seed banks and improving the illustration of the results, both methods were necessary. However, Roberts (1981) alluded to in Christoffoleti and Caetano (1998), communicated that the best and favoured technique of studying soil seed bank and recovery is to watch the advancement of the seedlings right on site. Investigation on soil seed bank has received massive attention with regards to its vital role in restoring and renovating plantations, preserving biological diversity, vegetation progression, dissemination forms and other areas of vegetation (Jiang *et al*., 2013). According to INHF (2001), soil seed banks are a network of seeds present in the soil and are equipped for survival. The upcoming vegetation that takes over a place after a severe interference usually arises from the soil seed bank of the zone hence, it amply affects the continuity of plant species (Alemu, 2016).

The soil seed bank is the storage house of feasible weed seeds accessible on the outside of the soil and randomly spread all through the soil profile (Singh *et al.,* 2012; Begum *et al.,* 2006). It comprises of both new weed seeds as of late shed, and more established seeds that have held on in the soil from earlier years. In practice, the soil seed bank likewise incorporates the tubers, bulbs, rhizomes, and other vegetative structures through which a bit of our most genuine enduring weeds proliferate themselves. Agricultural soils can contain an expansive number of weed seeds and at least twelve vegetative weed propagules per square foot (Menalled, 2013).

Soil seed banks are not limited to any soil type or land use. Soil metal are non-biodegradable metals and derivatives which may have accummulated over time in the soil. They refer to any primary metal or alloy that has been used in a device and then recovered for reprocessing and subsequent reuse in another application. They comprise of soda cans, discarded food wrap foils, condemned door frames and windows, air conditioning units, electrical wirings, pots, kitchen sinks, roof accents, iron railings, electronic devices, automobiles, etc. They are often piled up continuously before being sold out to companies for recycling (Akpoveta *et al*., 2010). The formation of scrap metal sites differ among sites and is liable to the quantity of long periods of accumulation. In Nigeria, most of the urban areas have metal scrap dumpsites located in and around human settlements, close to motor mechanic workshops and fairly used motor spare parts markets (Uba *et al*., 2008).

There is an expanding amount of metal scrap dumpsites emanating from condemned vehicles, electronic parts, etc. because of the nonattendance of metal reusing frameworks in Nigeria (Ogundiran and Osibanjo, 2008). These scrap metals have been examined and appeared to effectively affect above ground vegetation and soil physicochemical properties. However, much has not been done regarding investigation on their impact on soil seed banks which is noteworthy. This study examines the soil seed bank flora of scrap metal dumpsites and the weed population in selected communities.

MATERIALS AND METHODS

Soil samples were collected from nine (9) different locations within three (3) communities (Aluu, Nkpolu and Eliozu in Rivers state; six (6) scrap metal dumpsites and three (3) control sites. Geographical locations were recorded using a Garmin GPSMAP 64S device (Table 1).

Soil samples were obtained from both the soils in scrap metal dumpsites and control sites in 2018. The soil samples were randomly collected from the top 0-5cm, 5-10cm and 10-15cm of the topspoil (surface soil) using a soil auger. The soil samples was collected four times at different locations within the site and homogenise

The samples were collected into well labelled polythene bags and transported to the Centre for Ecological studies in the University of Port Harcourt where they were air-dried and sieved . The soil samples for physical and chemical analyses were taken to the laboratory.

Soil samples were later subjected to seedling emergence test in order to determine seed viability, density and species composition in the different locations and depths. A weight of 100g of the soil samples were put in perforated plates in which Whatman No. 1.5 filter paper was placed at the bottom to prevent water loss.

TABLE 1: Geo-coordinates of the study sites

Locations/Sites	Northing (y)	Easting (x)
Aluu scrap metal (Location 1)	04.90999°	006.90675°
	04.90998°	006.90672°
Aluu scrap metal (Location 2)	04.90685°	006.90736°
	04.90676°	006.90729°
Aluu Control Site	04.91022°	006.90649°
	04.91029°	006.90642°
Nkpolu scrap metal (Location 1)	04.86886°	006.97842°
	04.86889°	006.97849°
Nkpolu scrap metal (Location 2)	04.86969°	006.98438°
	04.86968°	006.98431°
Nkpolu Control Site	04.86660°	006.99102°
	04.86669°	006.99093°
Eliozu scap metal (Location 1)	04.86161°	007.01279°
	04.86171	007.01290°
Eliozu scrap metal (Location 2)	04.85913°	007.02348°
	04.85908°	007.02344°
Eliozu Control Site	04.85916°	007.01180°
	04.85894°	007.01144°

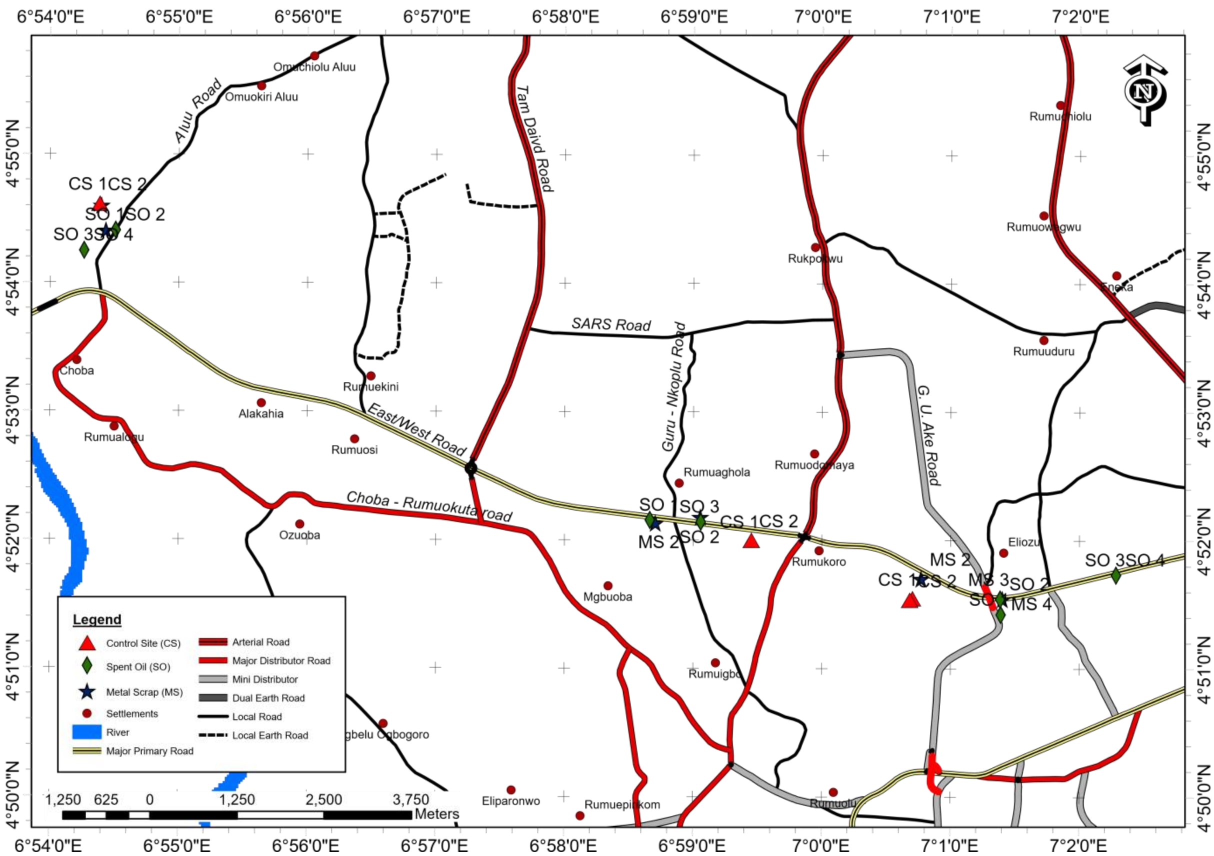

Fig. 1: Map of a Section of Rivers State Nigeria showing three communities with scrap metal dumpsites sampled for seed bank flora.

The plated soil samples were watered daily and monitored for seedling emergence. As the seedlings emerged, they were identified, counted and recorded weekly for 12 weeks. Most of the emerging seedlings were identified to species level *in situ* with assistance of the University of Port Harcourt Herbarium. The unidentified ones in situ were counted and transplanted till they grew morphologically amd then identified.

Data collected for seedling emergence were analysed using two-way analysis of variance to determine if there were significant differences (P=0.05). Also, multiple comparison using least significant difference (LSD) was applied to separate means with significant differences. This was done to compare seedling emergence from the seed banks of the scrap metal samples and control sites and number of emergent seedlings from the various depths.

RESULTS AND DISCUSSION

The study accounted for a sum of 1,187 seedlings which emerged from the nine study sites. The control sites had 996 and scrap metal dumpsite site 191 seedlings. A sum of 27 plant species from 16 families were identified and recorded. Poaceae family with 7 species, had the highest number of plant species. Rubiaceae and Asteraceae had 3 species each, Lamiaceae had 2 species, while the other families; Cyperaceae, Phyllanthaceae, Amaranthaceae, Schrophulariaceae, Malvaceae, Piperaceae, Portulacaceae, Onagraceae, Solanaceae, Fabaceae, Urticaceae, and Selaginellaceae had 1 species. (Tables 1).

The control sites had more species when compared with the scrap metal dumpsites. The plant species that were common to all locations and study sites were *Oldenlandia corymbosa*, *Eleusine indica, Lindernia sp* and sedges. For the scrap metal dumpsites, *Oldenlandia corymbosa*, *Eleusine indica* and Sedges were seen to grow in these sites. This implies that they can possibly be prevalent in these contaminated sites in contrast with other plant species. Their population was significantly higher than the scrap metal dumpsites at 5% significant level (Table 1).

The various treatments at 0-5cm depth showed that for Aluu location, metal scrap soil had the lowest seedling emergence. Control site had the highest and was significantly higher than scrap metal dumpsite at 5% significant level between treatments. For Nkpolu, scrap metal dumpsite was lower while control had the highest rate of seedling emergence and was significantly different from scrap metal dumpsites at 5% significant level between treatments. In Eliozu, scrap metal dumpsites had a lower seedling emergence as compared to the control sites which had the highest number of emergent seedling (Table 2).

For the various treatments across the locations (Aluu, Nkpolu and Eliozu), at 0-5cm depth, control had the highest number of seedlings and was significantly different in comparison to the scrap metal dumpsites. At 5-10cm depth, Aluu location metal scrap dumpsite had the lowest number of seedlings while control site had the highest number of seedlings and was significantly different from the scrap metal dumpsites at 5% significant level between the treatments. Scrap metal dumpsites also had the least number of seedlings for Nkpolu while control was seen to be the highest and was significantly different from scrap metal at 5% significant level between treatments. Eliozu location scrap metal dumpsite also had the least number of emergent seedlings. Control site had the highest number of seedlings and was significantly different from that of scrap metal dumpsite. At 5-10cm depth, it was still observed that for all the locations studied, control had the highest number of seedlings and was significantly different at 5% significance level when contrasted with those of the scrap metal dumpsites (Table 3).

At 10-15cm depth, for Aluu location metal scrap dumpsite had the lowest seedling emergence while the control site had the highest number of seedlings. The differences however were significantly different. It implies that the effect of the scrap metal decreased as the soil depth increased. For Nkpolu, scrap metal had the lowest number of seedling emergence. Again, control had the highest number of seedlings and was significantly different from scrap metal at 5% significant level between treatments.

Comparing each treatment across the various locations; at 0-5cm depth, Aluu scrap metal had the least amount of seedlings followed by Nkpolu scrap metal with Eliozu scrap metal having the highest amount of seedling emergency and was significantly different from Aluu and Nkpolu scrap metal at 5% significant level between locations. This explains that effects of scrap metal varies between different locations and its impact on seedling emergence may be seen at varying degrees. This agrees with Akpoveta *et al*. (2010) where they stated that there was a variety in the proportion of heavy metals in the soil among the different scrap metal dumpsites across the various locations and all things considered, variation also in their seedling emergence.

Table 1: Weed seed population, enumerated scrap metals and control sites in Rivers State Nigeria

			Aluu		Nkpolu		Eliozu	
	Species	**Family**	**Metal Scrap**	**Control**	**Metal Scrap**	**Control**	**Metal Scrap**	**Control**
1	*Oldenlandia corymbosa* L.	Rubiaceae	36	37	20	292	24	217
2	*Eleusine indica* (L.) Gaertn.	Poaceae	0	2	4	80	0	27
3	*Sedges*	Cyperaceae	18	9	22	85	28	66
4	*Ageratum conyzoides L.*	Asteraceae	0	2	0	5	0	3
5	*Oplismenus burmannii (Retz.) P. Beauv.*	Poaceae	0	1	0	2	0	0
6	*Chromolaena odorata (L.) R.M. King and H. Rob.*	Asteraceae	0	1	0	3	0	0
7	*Phyllanthus amarus L.*	Phyllanthaceae	3	4	1	43	8	7
8	*Amaranthus* sp. *L.*	Amaranthaceae	0	1	0	0	0	0
9	*Axonopus compressus (Sw.) P. Beauv.*	Poaceae	0	1	1	0	0	0
10	*Paspalum scrobiculatum L.*	Poaceae	0	1	0	0	0	1
11	*Lindernia* sp.	Scrophulariaceae	5	15	6	6	3	10
12	*Digitaria horizontalis* Haller	Poaceae	0	1	3	1	0	1
13	*Sida* sp. L.	Malvaceae	0	2	0	0	0	0
14	*Peperomia pellucida* Kunth	Piperaceae	0	5	0	1	0	0
15	*Talinum triangulare* Jacq.	Portulacaceae	0	1	0	4	1	0
16	*Platostoma* sp.	Lamiaceae	0	1	0	1	0	0
17	*Echinochloa colona* (L.) Link	Poaceae	1	1	0	1	0	0
18	*Cynodon dactylon* (L.) Pers.	Poaceae	0	2	1	9	2	0
19	*Ludwigia* sp.	Onagraceae	0	2	0	0	2	0
20	*Physalis* sp.	Solanaceae	1	14	1	1	0	0
21	*Solenostemon monostachyus* (P. Beauv.)	Lamiaceae	0	1	0	0	0	0
22	*Senna* sp	Fabaceae	0	0	0	1	0	0
23	*Spermacoce ocymoides* L.	Rubiaceae	0	0	0	0	0	1
24	*Pouzolzia guineensis* Benth.	Urticaceae	0	1	0	0	0	0
25	*Selaginella* sp.	Selaginellaceae	0	18	0	0	0	0
26	*Borreria* sp.	Rubiaceae	0	4	0	0	0	0
27	*Eleutheranthera ruderalis* (Sw.) Sch. Bip.	Asteraceae	0	1	0	0	0	0
	Number of Individuals		**64**	**128**	**59**	**535**	**68**	**333**
	Number of Species		**6**	**25**	**9**	**16**	**7**	**9**

Table 2: Differences in the number of emergent seedlings in selected scrap metal dumpsite and control site at 0-5cm depth in Rivers state, Nigeria

Treatments	Locations		
	Aluu	Nkpolu	Eliozu
Metal Scrap (MS)	0.33 ± 0.44^b	0.50 ± 0.47^b	0.75 ± 0.58^b
Control	6.33 ± 5.85^a	27.91 ± 46.59^a	9.08 ± 16.42^a
LSD	2.873	22.344	7.884

Means $\pm$ standard deviation with different alphabets are significant at 5% probability level.

Table 3: Differences in the number of emergent seedlings in selected scrap metal dumpsites and control at 5-10cm depth in Rivers State, Nigeria

Treatments	Locations		
	Aluu	Nkpolu	Eliozu
Metal Scrap (MS)	0.58 ± 0.66^b	0.33 ± 0.57^b	1.20 ± 0.80^b
Control	2.50 ± 2.23^a	5.75 ± 7.02^a	10.83 ± 13.73^a
LSD	1.1908	3.4189	6.625

Means $\pm$ standard deviation with different alphabets are significant at 5% probability level.

Table 4: Differences in the number of emergent seedlings in selected scrap metal dumpsite and control site at 10-15cm depth

Treatments	Locations		
	Aluu	Nkpolu	Eliozu
Metal Scrap (MS)	0.62 ± 0.71^a	0.50 ± 0.90^b	0.75 ± 0.65^b
Control	1.83 ± 2.88^a	10.91 ± 11.95^a	7.83 ± 9.39^a
LSD	1.512	5.759	4.5426

Means $\pm$ standard deviation with different alphabets are significant at 5% probability level.

Aluu control site had the least number of seedling emergence followed by Eliozu. Nkpolu control site was the highest was not significantly different between the control of Aluu and Eliozu locations at P<0.05. Aluu having the lowest number of seedling emergence amongst the control sites was be as a farmland which was influence by human interference such as tillage. Nkpolu control site which had the highest number of seedling emergence was an abandoned land without any form of interference. This is in accordance with Li *et al*. (2017) where they observed that an abandoned, undisturbed land had higher species richness and seed density when contrasted with a farmland. This also conforms to Zabinski *et al*., (2000) (Table 5).

At 5-10cm depth, comparing each treatment across the various locations, for scrap metal dumpsite at Nkpolu had the least followed by Aluu. Eliozu scrap metal was the highest and was significantly different from Nkpolu and Aluu scrap metal at 5% significant level between locations. For control, Aluu control had the least number of seedlings followed by Nkpolu control. Eliozu control had the highest number of seedling emergence and was significantly different from Aluu and Nkpolu control at 5% significant level between locations (Table 6)

At 10-15cm depth for the various locations, for scrap metal, Nkpolu had the least number of seedlings followed by Aluu. Eliozu had the highest number of seedlings but was not significantly different from Nkpolu and Aluu metal scrap at 5% significant level between locations. For control, Aluu was seen to be the least followed by Eliozu. Nkpolu dumpsite control had the highest number of seedling emergence and was significantly different from Aluu and Eliozu control at 5% significant level between locations. (Table 7)

Table 5: Differences in the number of emergent seedlings in selected scra metal dumpsites and control site at 0-5cm Depth in River State,Nigeria

Locations	Scrap Metal Dumpsite	Control sites
Aluu	0.33 ± 0.44^{b}	6.33 ± 5.85^{a}
Eliozu	0.83 ± 0.61^{a}	9.08 ± 16.42^{a}
Nkpolu	0.50 ± 0.47^{ab}	27.91 ± 46.59^{a}
LSD	0.4297	23.855

Mean $\pm$ standard deviation with different alphabet is significant at 5% probability level.

Table 6: DifferenceS in the number of emergent seedlings for the various locations at 5-10cm depth

Location	Metal Scrap	Control
Aluu	0.58 ± 0.66^{ab}	2.50 ± 2.23^{b}
Eliozu	1.20 ± 1.25^{a}	10.83 ± 13.73^{a}
Nkpolu	0.33 ± 0.57^{b}	5.75 ± 7.02^{ab}
(ANOVA)	3.12	2.61
p-value	0.0576	0.0884
LSD	0.7346	7.4752

Mean $\pm$ standard deviation with different alphabet is significant at 5% probability level.

Table 7: Differences in the number of emergent seedlings in the selected scrap metal dumpsites and control site at 10-15cm depth in Rivers state, Nigeria

Location	**Metal Scrap**	**Control**
Aluu	0.62 ± 0.71^{a}	1.83 ± 2.88^{b}
Eliozu	0.75 ± 0.65^{a}	7.83 ± 9.36^{ab}
Nkpolu	0.50 ± 0.90^{a}	10.91 ± 11.95^{a}
LSD	0.6354	7.4237

Mean $\pm$ standard deviation with different alphabet is significant at 5% probability level.

Comparing each treatment across the various depths for Aluu location, results showed that for scrap metal dumpsite, it was lowest at 0-5cm depth followed by 5-10 cm depth. It was highest at 10-15 cm depth but was not significantly different from 0-5 cm and 5-10 cm depth at 5% significant level between depths. Control was lowest at 10-15 cm depth followed by 5-10cm. It was highest at 0-5cm and was significantly different from 10-15 cm and 5-10 cm depth at 5% significant level between depths (Table 8).

At Nkpolu, result demonstrated that scrap metal dumpsite was lowest at 5-10 cm depth followed by 0-5 cm depth. 10-15 cm depth had the highest number of seedling emergence with just a slight difference from 0-5cm depth and was not significantly different from 5-10 cm and 0-5 cm depths at 5% significant level between depths. The control site at Nkpolu site was the lowest at 5-10 cm depth followed by 10-15cm. The control site was highest at 0-5 cm depth but was not significantly different from 5-10 cm and 10-15 cm depths at $P < 0.05$ (Table 9).

In Eliozu, results showed that scrap metal was lowest at 0-5cm depth followed by 10-15cm depth. It was highest at 5-10cm depth but was not significantly different from 0-5cm and 10-15cm depths at 5% significant level between depths. The control site appeared to be lowest at 10-15cm depth followed by 0-5 cm. 5-10 cm depth was highest but was not significantly different from 10-15 cm and 0-5 cm depths at 5% significant level between depths. This goes to show that depths had no significant difference among the different treatments. This opposes Akande *et al*. (2018) where they stated that there was significant difference (decrease) in seed viability with increase in soil depth for both contaminated and control site (Table 10).

Table 8: Differences in number of emergent seedlings across various depths for Aluu community in Rivers state, Nigeria

Depths	Metal Scrap dumpsite	Control
0-5cm	0.33 ± 0.44[a]	6.33 ± 5.85[a]
5-10cm	0.58 ± 0.66[a]	2.50 ± 2.23[b]
10-15cm	0.62 ± 0.71[a]	0.50 ± 0.90[b]
LSD	0.5142	3.0352

Mean ± standard deviation with different alphabet is significant at 5% probability level.

Table 9: Difference in number of emergent seedlings across various depths for Nkpolu community in Rivers state, Nigeria.

Depths	Metal scrap dumpsite	Control site
0-5cm	0.50 ± 0.47[a]	27.91 ± 46.59[a]
5-10cm	0.33 ± 0.57[a]	5.75 ± 7.02[a]
10-15cm	0.50 ± 0.90[a]	10.91 ± 11.95[a]
LSD	0.5631	23.31

Means ± standard deviation with different alphabets are significant at 5% probability level.

Table 10: Difference in number of emergent seedlings across various depths for Eliozu community in Rivers state, Nigeria

Depths	Metal Scrap	Control
0-5cm	0.75 ± 0.58[a]	9.08 ± 16.42[a]
5-10cm	1.20 ± 1.25[a]	10.83 ± 13.73[a]
10-15cm	0.75 ± 0.65[a]	7.83 ± 9.39[a]
LSD	0.7334	11.213

Means ± standard deviation with different alphabets are significant at 5% probability level.

Soil depth of 0-5cm in control site had higher diversity in Aluu and Nkpolu sites, followed by the scrap metal dumpsites. In Eliozu sites, scrap metal had close species diversity range with control. Same result was obtained using Margalef (Tables 11, 12 and 13).

For 5-10 cm using Shannon-Wienner index, control site had higher species diversity in Aluu followed by scrap metal. In Nkpolu, scrap metal had higher species diversity keenly followed by control. In Eliozu, species diversity was at a close range between scrap metal and control (Tables 11, 12 and 13).

At 10-15 cm depth, using Shannon-Wienner index, scrap metal had higher species diversity and than control. Nkpolu control site had higher species diversity followed by scrap metal. In Eliozu, control site had higher diversity followed by scrap metal. Generally, the control sites had higher species diversity especially at 0-5 cm depth when contrasted with the scrap metal dumpsites. This conforms to Dedeke and Akomolafe (2014) where they observed that a control site had the highest species diversity which recommend that there is an immediate connection between plant diversity and plant growth (Tables 11, 12 and 13).

Table 11: Species diversity for soil seed bank (0-5cm depth) of scrap metal dumpsites and associated control sites in Rivers state, Nigeria

	Aluu		Nkpolu		Eliozu	
	Metal Scrap	Control	Metal Scrap	Control	Metal Scrap	Control
Taxa_S	3	23	5	13	6	6
Individuals	21	76	24	335	18	109
Dominance_D	0.5283	0.1174	0.3368	0.3416	0.2716	0.3687
Simpson_1-D	0.4717	0.8826	0.6632	0.6584	0.7284	0.6313
Shannon_H	0.7732	2.551	1.293	1.394	1.523	1.271
Evenness_e^H/S	0.7222	0.5572	0.7284	0.31	0.7643	0.594
Brillouin	0.6481	2.197	1.072	1.337	1.195	1.186
Menhinick	0.6547	2.638	1.021	0.7103	1.414	0.5747
Margalef	0.6569	5.08	1.259	2.064	1.73	1.066
Equitability_J	0.7038	0.8135	0.8031	0.5434	0.85	0.7093
Fisher_alpha	0.9578	11.21	1.922	2.69	3.152	1.366
Berger-Parker	0.6667	0.2368	0.5	0.5224	0.4444	0.5413
Chao-1	3	53.33	5	18	6.5	6

Table 12: Species diversity for soil seed bank (5-10cm depth) of scrap metal dumpsites and associated control sites in Rivers state, Nigeria

	Aluu		Nkpolu		Eliozu	
	Metal Scrap	Control	Metal Scrap	Control	Metal Scrap	Control
Taxa_S	4	7	5	5	5	7
Individuals	23	30	17	69	30	130
Dominance_D	0.38	0.3289	0.3564	0.4056	0.3911	0.5639
Simpson_1-D	0.62	0.6711	0.6436	0.5944	0.6089	0.4361
Shannon_H	1.126	1.472	1.222	1.186	1.122	0.9071
Evenness_e^H/S	0.771	0.6224	0.679	0.6549	0.614	0.3539
Brillouin	0.9438	1.218	0.9601	1.083	0.9521	0.8379
Menhinick	0.8341	1.278	1.213	0.6019	0.9129	0.6139
Margalef	0.9568	1.764	1.412	0.9447	1.176	1.233
Equitability_J	0.8124	0.7563	0.7594	0.737	0.697	0.4662
Fisher_alpha	1.399	2.871	2.387	1.238	1.713	1.584
Berger-Parker	0.5217	0.5333	0.4706	0.5942	0.5	0.7308
Chao-1	4	7.5	8	5	5.5	7.5

TABLE 13: Species diversity for soil seed bank (10-15cm depth) of scrap metal dumpsites and associated control sites in Rivers state, Nigeria

	Aluu		Nkpolu		Eliozu	
	Metal Scrap	Control	Metal Scrap	Control	Metal Scrap	Control
Taxa_S	5	7	6	10	3	6
Individuals	20	22	18	131	20	94
Dominance_D	0.34	0.2314	0.2284	0.3789	0.355	0.4957
Simpson_1-D	0.66	0.7686	0.7716	0.6211	0.645	0.5043
Shannon_H	1.277	1.654	1.6	1.405	1.067	0.9879
Evenness_e^H/S	0.7174	0.7469	0.8255	0.4077	0.969	0.4476
Brillouin	1.033	1.328	1.265	1.298	0.9084	0.9081
Menhinick	1.118	1.492	1.414	0.8737	0.6708	0.6189
Margalef	1.335	1.941	1.73	1.846	0.6676	1.101
Equitability_J	0.7936	0.85	0.893	0.6103	0.9713	0.5514
Fisher_alpha	2.14	3.544	3.152	2.519	0.9788	1.428
Berger-Parker	0.5	0.3636	0.3333	0.5802	0.45	0.6702
Chao-1	6	8.5	6.5	13	3	6.5

The pH value for the scrap metal sites was not affected as it was not significantly different from those of the control sites. Physical and chemical parameters in Aluu scrap metal site, Nkpolu scrap metal site, Eliozu scrap metal site and control sites had no significant difference at P= 0.05. The soil types of the various scrap metal dumpsites were also significantly related to each other but were not significantly similar to the control sites.

Results for the heavy metal (copper, zinc and lead) analysis showed that of Nkpolu and Eliozu scrap metal sites were significantly related. Copper, lead and zinc concentrations were above the WHO (1996) permissible limits in soil (36mg/kg; Pb:85mg.kg; Zn: 50mg.kg) for all the site besides the control site. This conforms with Jaradat *et al*. (2005) where they stated that heavy metals in soil samples from a scrap metal yard was discovered to be higher than those of the control samples and it was attributed to piles of scrap metal and the activities related to them. This is also in accordance with Akpoveta *et al*. (2010) and Jesen *et al*. (2002).

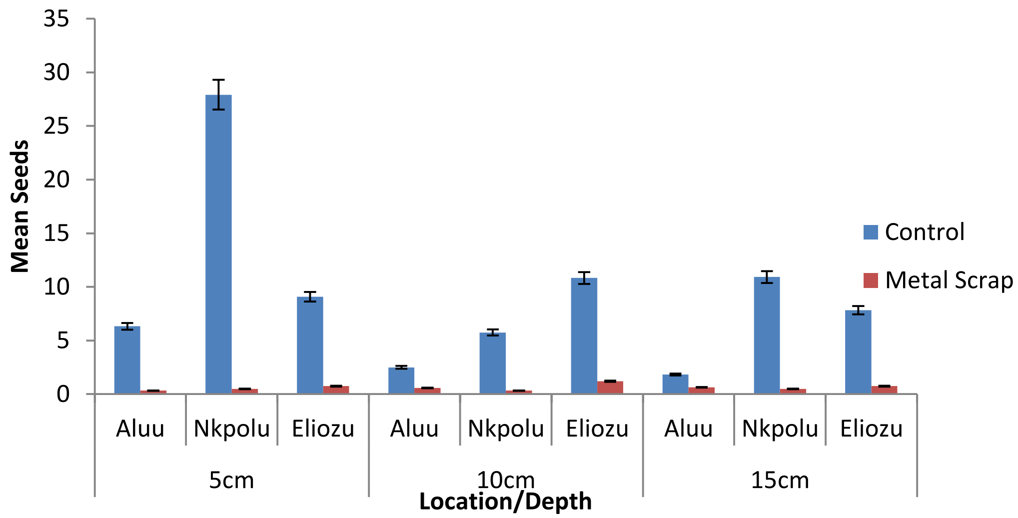

Fig. 2: Mean number of seeds for control, spent engine oil and scrap metal sites across the various depths and locations in Rivers state Nigeria

CONCLUSION

Soil weed seed bank provides historical flora of an ecosystem location. The control sites for the various locations studied had the highest number of emergent seedlings with about 80% of the total number of seedlings in comparison to the scrap metal dumpsites. Also, the impact of the scrap metal differed significantly between locations but was not significant when comparing depths within same locations. The control sites had more species diversity especially at the top soil (0-5cm) when compared with the scrap metal dumpsites.

From this study, it can be inferred that scrap metal had a significantly adverse effect on the soil seed banks composition, abundance and diversity in the areas studied. This is a serious environmental challenge as these scrap metal dumpsites continue to increase in Nigeria. Necessary precautionary actions should be taken to protect soil banks of the scrap metal dumpsite studied.

REFERENCE

Akande, F.O., Ogunkunle, C.O. and Ajayi, S.A. (2018). Contamination from Petroleum Products: Impact on Soil Seed Banks around an Oil Storage Facility in Ibadan, South-West Nigeria. *Pollution*, 4(3): 515-525.

Akpoveta, O.V., Osakwe, S.A., Okoh, B.E. and Otuya, B.O. (2010). Physicochemical characteristics and levels of some heavy metals in soils around metal scrap dumpsites in some parts of Delta State, Nigeria. *Journal of Applied Science and Environmental Management*, 14(4): 57-60.

Alemu, M.M. (2016). Soil Seed Bank and Natural Regeneration of Trees. *Journal of Sustainable Development*, 9(2): 73-78.

Anyanwu, f. U, Ochekwu, E.B. Ndukwu, B.C and Ogazie, C.A (2019): Soil weed seed bank studies in spent engine oil sites in some communities in Rivers state, Nigeria. *International Research Journal of Applied Sciences, Engineering and Technology* vol.5, no.12; december-2019;pp 33 - 46

Baker, H.G. (1989). Some aspects of the natural history of seed banks. In: Leck, M.A., Parker, V.T. and Simpson, R.L. (eds). *Ecology of soil seed banks*, 5-19. Academic Press, London.

Begum, M., Juraimi, A.S., Rastan, S.O.B.S., Amartalingam, R. and Man, A.B. (2006). Seedbank and seedling emergence characteristics of weeds in rice field soils of the muda granary area in north-west peninsular Malaysia. *Biotropia*, 13(1): 11-21.

Christoffoletti, P.J. and Caetano, R.S.X. (1998). Soil seed banks. *Scientia Agricola*, 55: 74- 78.

Dedeke, O.A. and Akomolafe, G.F. (2014). Soil seed bank and floristic diversity as affected by spent engine oil. *Universal Journal of Environmental Research and Technology*, 4(2): 100-108.

Gonzalez, S.L. and Ghermandi, L. (2012). Comparison of methods to estimate soil seed banks: The role of seed size and mass. *Community ecology*, 13(2): 238-242.

INHF (Iowa Natural Heritage Foundation), (2001). *Secrets of the Seed Bank: Tiny Clues to a Landscape's Past and Future*. Des Moines, IA 50309-2321.

Jaradat, Q.M., Massadeh, A., Zaitoun, M. and Maitah, B.M. (2005). Heavy metal contamination of soil, plant and air of scrap yard of discarded vehicles at Zarqa city, Jordan. *Soil and sediment contamination*, 14(5): 449-462.

Jensen, D.L., Holm, P.E. and Christensen, T.H. (2002). Soil and groundwater contamination with heavy metals at two scrap iron and metal recycling facilities. *Waste Management and Research*, 18(4): 367-379.

Jiang, D., Wang, Y., Oshida, T., Luo, Y., Wang, H. and Zhou, Q. (2013). Review of research on soil seed banks in desert regions. *Disaster Advances*, 6(1): 315-323.

Li, H.Y., Mo, X.Q. and Hao, C. (2009). A review of study on soil seed bank in the past thirty years. *Ecology and Environmental Science*, 18(2): 731-737.

Menalled, F.D. (2013). *Manage the Weed Seed Bank-Minimize "Deposits" and Maximize "Withdrawals"*. Available at: extension.org http://www.extension.org/pages/18527/ manage-the-weed-seed bank minimize-deposits-and maximize-withdrawals#. VkG6 Xl53C1t.

Moore, P.D. (1980). Soil seed banks. *Nature*, 284(13): 123-124.

Ochekwu**.** E.B**,** Chukwu, F.U., and Nichodemus, C.O.(2022): Variation In Species Composition and Diversity of a Soil Seed Bank: a Dumpsite and a Fallow Field .Proceedings of

Ecological Society Of Nigeria Ecoson-Ibadan 2022 May 15th to May 19th 2022 IBD22P01 pp 6 - 14.

Ogundiran, M.B. and Osibanjo, O. (2008). Heavy metal concentrations in soils and accumulation in plants growing in a deserted slag dumpsite in Nigeria. *African Journal of Biotechnology*, 7(17): 3053-3060.

Plue, J., Thompson, K., Verheyen, K. and Hermy, M. (2012). Seed banking in ancient forest species: why total sampled area really matters. *Seed Science Research*, 22(2): 123-133.

Roberts, H.A. (1981). Seed banks in the soil. *Advances in Applied Biology*, 6:1- 55. Cambridge, Academic press.

Simpson, R.L., Leck, M.A. and Parker, V.T. (1989). Seed banks: General concepts and methodological issues. In: Leck, M.A., Parker, V.T. and Simpson, R.L. (eds). *Ecology of soil seed banks*. 3-8. London: Academic Press.

Singh, A., Kaur, R., Kang, J.S. and Singh, G. (2012). Weed dynamics in rice-wheat cropping system. *Global Journal of Biology, Agriculture and Health Sci*ences, 1(1): 7-16.

Thompson, K. and Grime, J.P. (1979). Seasonal variation in the seed banks of herbaceous species in ten contrasting habitats. *Journal of Ecology*, 67(3): 893- 921.

Tsuyuzaki, S. (1994). Rapid seed extraction from soils by a flotation method. *Weed Research*, 34(6): 433-436.

Uba, S., Uzairu, A., Harrison, G.F.S., Balarabe, M.L. and Okunola, O.J. (2008). Assessment of heavy metals bioavailability in dumpsites of Zaria Metropolis, Nigeria. *African Journal of Biotechnology*, 7(2):122-130.

WHO (1996): Permissible limits of heavy metals in soils and plants (Geneva: World Health Organization, Switzeland).

Zabinski, C., Wojtowicz, T. and Cole, D. (2000). The effects of recreation disturbance on subalpine seed banks in the Rocky Mountains of Montana. *Canadian Journal of Botany*, 78(5): 577–582.