International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
(A Peer Reviewed, Referred, Indexed and Open Access Journal)
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 9, Issue 12 -2022

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2022.09.12.005

Estimation of the population size of plant species at three generator house vegetations in Rivers State University

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Abstract

The estimates of population size of plants species were investigated at three diesels impacted site from electrical generator units (Medical science (site A),RSU Works Department (Site B), Faculty of Agriculture GH (site C) and control (site). A simple sampling technique which was based on standard procedure for quantitative ecological assessment was adopted for the study. The dominant plant species located in each sample unit were characterized by counting and identified using a handbook of West African Weeds (IITA), white soil samples from each site was analyzed for Cd and Pb to obtain phytosociological data. Results showed that the concentration of Pb and Cd were above WHO tolerance limit with RSU Works GH showing the highest 15.0mg/kg and 95.5 mg/kg for Cd and Pb respectively. The phytosociological analysis showed that the predominant species recorded belongs to the families of Cyperaceae, Asteraceae, Euphorbiaceae. In the three sampling stations, two plant species showed higher frequency of distribution pattern for site A: 38 (100%) and 30 (100%), site B: 53 (100%) and 32 (80%), site C: 21 (100%) and 7(60%) was recorded for *Cyperus difformis* and *Euphorbia hyssopifolia* respectively. The control site (site D) showed a relative increase in frequency distribution pattern in all dominant plant species recorded. *Tridax procumbens,* 41 (100%) and *Cyperus difformis* 69 (100%) recorded highest rate of frequency of occurrence. Base on the result obtained *Cyperus difformis* and *Euphorbia hyssopifolia* could be regard as bioindicators since the frequency of occurrence increased with increase in pollutant.

Keywords: Heavy metal, diesel, pollution, environment

1. Introduction

Man is facing one of the major ecological crises in recent times which in times past was purely unperturbed hospitable environment. Pollution is an unwanted change in the major constituent of the environment (Lithosphere, Atmosphere and Hydrosphere) with adverse effect on its biological characterization which may affect human life and there living conditions (Ali *et al.,* 2013). The effect of pollution has altered the ecological balance of the environment, largely as a result of human interference. Ramesh et al., (2013) associated human population explosion with pollution problem. Increase in human population give rise to increase in sewage production, solid

wastes, more fuel being burned, more fertilizer application and insecticides. The issue of pollution is less severe in technological develop countries and yet the populations may be very dense (Ramesh *et al.,* 2013). Pollution could range from point and non-point sources (McGrath *et al*., 2001).Man's activities and desire to satisfy his wants led to excessive exploitation of the environment. Exploitation ought to proceed with environmental sustainability (preservation and conservation). However, the failure of man in considering the needful has led to the formation of various types of pollution such as air, water, noise, radioactive, solid waste and land (Ramesh et al., 2013). Babagana *et al.* (2015) accounted that man is lost in thought in exploiting the environment without taking into consideration the harmful effects of his actions on the environment. Man in all his exploitation actions has been diffident from all his responsibilities. According to Ola *et al.* (2015) "Ignoring responsibilities cannot prevent its consequences". The negative and noxious pollutants on the environment result in environmental instability, thereby altering the natural habitat of organisms. Crude oil which was first discovered in 1956 at Oloibiri Bayelsa State in Niger Delta region of Nigeria by Shell- BP was envisaged to increase Nigeria's economy and account above 90% of her gross earnings alongside the traditional mainstay of the economic which is agriculture. Environmental degradation through oil exploration pushed agriculture to the background (Babagana *et al.*, 2015). The presence of oil and its components on the environment influenced the ecological amplitude of plants and animals in their natural environment. Adequate growth and reproduction are directly linked to a suitable unperturbed soil conditions (Ramesh *et al.,* 2013).The presence of oil in the environment impedes plants performance, porosity which is an essential physical indicator that create space for water and air percolation. This is essential to enhance adequate aeration of the plants and increase its water availability. A good soil ought to have good pore space of 30-50% but the presence of oil tends to influence this pore space, thus depriving plants from its optimum performance (Johnson *et al*., 2013). The soil chemistry which deals on the capacity of nutrient needed by plants is also negatively impacted by crude oil and its component. Soil pH has as strong influence on nutrient availability with a range between 5.5-7.0 for optimal plants growth (Perry, 2012)

2. Materials and Methods

Study area:

This investigation was conducted within Rivers State University Premises. Rivers State is located in the tropical rainforest region of southern Nigeria and it is popularly referred as Niger Delta region because it is found among the Niger Delta States. According to Dike and Nwachukwu, (2003), the region has a daily and annual temperatures of 36^{oc} and 28^{oc} with a 2400mm mean annual rainfall which peaks at July and September (Uko and Tamunobereton-Ari, 2013). In this area, relative humidity and sunshine are high. This area shows two main seasons- The rainy season starts from April to October while the dry season starts from November to March. The climatic pattern of this area influences negatively on the nutrient pattern (Kinako *et al*., 1993).

Vegetation Sampling:

Sampling of the grassland vegetation was done at 5m away from the three-generator points (Medical science site (A), RSUWorks Department site (B) and Faculty of Agriculturesite (C)) at latitude and longitude of 4.79709, 6.9799; 4.79741, 6.98316; 4.79072, 6.98162 respectively using a simple technique based on standard procedure for quantitative ecological assessment. Transect and quadrat methods were adopted in studying and characterizing the dominant plant species. A measurement of 5m along the study area was made using a transect, and sampling was done at 1m intervals with the quadrat which was placed at the start of the line transect, this method was also adopted in sampling the control site (D) (Lat 4.79059, long. 6.98042). The dominant plant species located in each sample unit were characterized by counting and identified using a handbook of West African Weeds (IITA), to

obtain phytosociological data. After counting, the plants were harvested and rinsed to remove soil particle from the roots. The roots were separated from shoots by cutting, and the plant parts were carefully labeled with tags and placed in a cooler containing ice in other to maintain sample integrity. This method was adopted in sampling the four (4) vegetation sites. The soil samples were collected 5m away from the three different generator points at 0-15cm depth using soil auger, while the uncontaminated control soil samples were obtained from a fallow vegetation beside Fidelity Bank in the study area. The collected soil samples were placed in a polyethene bag with tags indicating collection points. All samples collected were taken to the laboratory for analysis.

Vegetation analysis

For the Vegetation analysis parameters such as species composition, abundance, frequency of occurrence, relative frequency, density, relative density, pH, conductivity and soil heavy metal content, TPH and TOC were observed and calculated.

Determination of plant species composition

The plant species composition within the sample plots were observed, photographed, collected and taken to the plant herbarium for identification.

Determination of species abundance

This refers to the number of individuals of a species per sampling unit of occurrence. The relative plant abundance of the sampling plots was estimated by calculating the number of individuals of a species per unit area. It was calculated according to Anyanwu *et al. (*2014*)*, using the formular:

Abundance:

$$\frac{\text{Total number of individuals}}{\text{Number of quadrats in which species occur}}$$

Determination of frequency of occurrence

Frequency refers to the degree of dispersion in terms of percentage occurrence. The frequency was calculated using the number of sampling units in percentage in which a given species occur when compared to the total number of sampling units used. Only the presence of a species in the sampling unit or plot was used (Anyanwu *et al.*, 2014).

Frequency %.

$$\frac{\text{Number of quadrats in which species occurred}}{\text{Total number of quadrats studied.}} \times 100$$

Relative Frequency:

$$\frac{\text{Number of quadrats in which species occurred}}{\text{Total number of all species in the quadrats}} \times 100$$

Determination of plant population density

Population density refers to the number of individuals of given species per unit area. It represents the numerical strength of the species in the community in a definite space or unit area. (Anyanwu *et al*, 2014). This was determined using the formula:

Density:

$$\frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}$$

Relative Density:

$$\frac{\text{Total number of individuals of a particular species in all quadrats}}{\text{Total number of individuals of all species in all quadrats}}$$

Determination of soil chemical parameters

Soil pH

pH was measured by meter method from slurry of 50/50 (W/V) of sample soil mixed with distilled water in a beaker which was stirred with a stirrer

for 5 mins to homogenize. pH meter (Jennway 3015 model) electrodes were dipped into solution and the pH value displayed in the meter was recorded.

Soil conductivity (us/cm)

Soil conductivity was measured by meter method from slurry of 50/50 (w/v) sample soil mixed with distilled water in a beaker. The mixture was stirred with a stirrer for 5 minutes to homogenize. Thereafter conductivity meter (HACH Ecttesr microprocessor series) electrodes were dipped into the solution and the conductivity value was recorded.

Determination of total hydrocarbon content (THC)

The spectrophotometer method was used to determine the Total hydrocarbon content (THC). 1g of oven dried sample was weighed and transferred into a test tube. 10ml of 99.9% chloroform was added to the sample in the test tube. The test tube was then corked and shaken for 15 seconds, after which it was placed on a rack till a clear supernatant and sediment was observed. The supernatant extract was read in a spectrophotometer at 420nm wavelength (Shooter spectrophotometer) using pure chloroform as blank. The concentration of THC was then extrapolated from a standard bonny light bonny medium crude plotted graph.

Determination of total organic carbon (TOC)

The Total organic carbon (TOC) was determined through oxidation method. 1g of the sample was weighed and transferred into a clean conical flask (250ml calibration). 5ml of potassium dichromate and 7.5ml concentrated solution of sulphric acid was added. The mixture was heated for about 15 minutes in an electro-thermal heater for oxidation to take place. The mixture was then allowed to cool at room temperature and diluted to 100ml with distilled water. 25ml of the solution was titrated with ferrous ammonium sulphate using ferroin as indicator. A blank was also set up in like manner and treated as described above. The titre value was then recorded and the value of the total organic carbon was calculated using the formula.

%TOC

$$= \frac{\textit{Titre value of blank-titre value of sample x } 0.2 \text{ x } 0.3}{\textit{Weight of sample}}$$

Determination of heavy metal

The soil samples were ground and sieved through 500µm sieve and then dried in an oven at 65^{o}C for 16hrs, samples were kept in a clean polythene bag for further analysis. One gram (1g) of soil samples were digested separately with 10cm^{3}of aqua regia (a mixture of 3 parts concentrated HCl to 1-part concentrated HNO_3) on a hot plate in a fume cupboard. The samples were then analyzed for Cd and Pb using Atomic Absorption Spectrophotometer (AAS) (BUCK scientific 200A model).

3. Results

Appreciable level of heavy metals in comparison with WHO permissible limit was detected at all sampled sites. Soil concentration of cadmium was highest atsite B with control site showing the least in soil cadmium. Site B also showed the highest increase in lead concentration, with a decrease recorded at the control site. A variation in soil pH and conductivity were observed, in the study sites, with highest alkalinity observed at site A when compared with control showed a slight acidity. Soil conductivity was highest at Site B. Cd and Pb concentrations was indicated as a trend as shown in table 1.

Table 1 Concentration of heavy metals present in soil of the various sampling location in (mg/kg)

Chemical PPT	Site A	Site B	Site C	Control
Cd	13.0	15.0	12.0	3.0
Pb	62.0	95.0	50.0	10
pH	8.3	8.04	8.2	6.3
Cond	520	650	500	90.3
TPH	8.1	18.1	11.14	0.001
TOC	7.3	12.9	8.5	1.02

Table 2. Target Value of Cd and Pb in soil (mg/kg)

Permissible limit	Soil	Plant
Cd	0.8	0.02
Pb	85	2

Source: Denneman and Robberse, 1990 and WHO 1996

Frequency of occurrence

High variation in species distribution was observed in the trend of species frequency distribution pattern and other phytosociological parameters in different sampling plot and area. The predominant species recorded belongs tothree (3) families such as Cyperaceae, Asteraceae, Euphorbiaceae. In the three sampling areas, two plant species showed higher frequency of distribution pattern. Site A:38 (100%) and 30 (100%) was recorded for *Cyperus difformis* and *Euphorbia hyssopifolia* respectively. Frequency distribution pattern was also recorded as 53 (100%) and 32 (80%) for the two plant species amongst the predominant species at site B and similar trend was also found insite C for *Cyperus difformis* and *Euphorbia hyssopifolia* as 21 (60%) and 7 (60%) respectively. The control site (site D) showed a relative increase in frequency distribution pattern in all dominant plant species recorded. *Tridax procumbens,* and *Cyperus difformis* recorded highest rate of frequency of occurrence in all sample sites as shown in table 3.

Plant population density

Table 3showed the density of species at the control and the various impacted sites. It was recorded that the density of plant species found in the site D was more than those in the various impacted sites. Decrease in density of the control site (site D) was recorded for *Euphorbia hyssopifolia*. Least decrease in density was found for site C across sampled sites than control.

Species abundance

It was observed that the abundance and relative abundance of species was higher in site Bapart from *Kyllinga erecta* in comparison with the various impacted sites and the control site. *Kyllinga erecta* showed a total number of individuals present in various sampling sites as 44%, 17%, 5% and 44% for Site A, Site B, Site C and control respectively. The least in species abundance for all dominant studied plant species was found in the impacted site that site C. This variation can be seen in table 3.

Table 3. Vegetation estimation of the various sampling sites.

			Nos. of individual in each quadrat sampled.												
	S/N	Plant Species	1	2	3	4	5	A	B	C	D%	E	F	G	H
SITE A	1	***Kyllinga erecta***	**0**	**9**	**10**	**15**	**10**	**4**	**5**	**44**	**80**	**8.8**	**11.0**	**9.1**	**30.1**
	2	*Tridax procumbens*	7	8	0	0	8	3	5	23	60	4.6	7.6	13.0	15.8
	3	*Cyperus difformis*	3	2	10	10	13	5	5	38	100	7.6	7.6	13.2	26.0
	4	*Euphorbia hyssopifolia*	8	8	5	9	6	5	5	30	100	6.0	6.0	16.7	20.1
	5	*Eclipta alba*	5	0	6	8	0	3	5	11	60	2.2	3.6	27.3	7.5
SITE B.	1	***Kyllinga erecta***	**5**	**12**	**0**	**0**	**0**	**2**	**5**	**17**	**40**	**3.4**	**8.5**	**11.0**	**11.8**
	2	*Tridax procumbens*	6	8	0	20	0	3	5	34	60	6.8	11.3	8.8	23.6
	3	*Cyperus difformis*	10	10	15	10	8	5	5	53	100	10.6	10.6	9.4	36.8
	4	*Euphorbia hyssopifolia*	9	8	0	7	8	4	5	32	80	6.4	8.0	13.0	22.2
	5	*Eclipta alba*	8	0	0	0	0	1	5	8	20	1.6	8.0	13.0	5.5
SITE C	1	***Kyllinga erecta***	**2**	**1**	**0**	**0**	**2**	**3**	**5**	**5**	**60**	**1.0**	**1.7**	**60**	**9.4**
	2	*Tridax procumbens*	0	0	0	6	8	2	5	14	40	2.8	7.0	14.3	26.4
	3	*Cyperus difformis*	9	10	0	0	2	3	5	21	60	4.2	7.0	14.3	39.6
	4	*Euphorbia hyssopifolia*	2	3	2	0	0	3	5	7	60	1.4	2.3	42.8	13.2
	5	*Eclipta alba*	4	1	1	0	0	3	5	6	60	1.2	2.0	50	11.3
CONTROL	1	***Kyllinga erecta***	**8**	**0**	**11**	**20**	**5**	**4**	**5**	**44**	**80**	**8.8**	**11.0**	**9.0**	**21.2**
	2	*Tridax procumbens*	8	9	13	10	1	5	5	41	100	8.2	8.2	9.8	19.8
	3	*Cyperus difformis*	8	15	16	11	19	5	5	69	100	13.8	13.8	7.2	33.3
	4	*Euphorbia hyssopifolia*	7	7	9	2	0	4	5	25	80	5	6.3	16	12.0
	5	*Eclipta alba*	6	8	4	10	0	4	5	28	80	5.6	7	14.2	13.5

A= Total number of quadrats of occurrence, B= Total number of quadrats studied, C= Total individuals, D= Frequency, E= Density, F= Abundance, G= Rel. Frequency, H= Rel Density.

4. Discussion

The fact remains that the tolerance of plants in environment polluted with crude oil and its components varies. Plant species present in an area polluted with crude oil component appear as excluders or accumulators. The excluders are plants prevalent in a polluted environment without having any known toxicity effects while the accumulators showed a reduction in their biomass. The reduction in biomass and species abundance could be attributed to the depletion in nutrient quality impose by toxic nature of the gasoline fuel from generator exhaust. This is statement is remarkabledue to increase rate of TPH and TOC recorded throughout the sample sites.These findings also corroborate with Brandt *et al.*, 2006 who reported that plant species grown in a polluted environment showed a reduction in growth rate and biomass production due to nutrient depletion caused by toxic hydrocarbon compounds. It was also observed that the decrease in species richness could be seen as the inability of plants to undergo ecological amplitude due to the presence of diesel on their habitat which tend to influence their role. Daniel-kalio and Pepple (2006) reported that the effects of diesel fuel on plants is found during the establishment of new seedlings, at this point some plant species that do not have the necessary mechanism to adapt dies off. This variation in time established during the formation of new seedlings influenced the degradation of hydrocarbons and availability of nutrients. Highest concentration of Pb, Cd observed in the sites B could be attributed to the presence of heavy metals in some hydrocarbon compounds. This agreed with Nduka *et al.*, (2006), who reported that crude oil found in Niger Delta region of Nigeria contains some appreciable level of heavy metals.The vegetation estimation of individuals in the various sample sites were observed to be variational. However,*Kyllinga erecta* showing highest number of individuals in all sample sites.This variation could be attributed to the concentration of pollution present in the various sampling sites. The decrease in number of individuals present in each sampling sites could be attributed to the toxic effect of diesel fuel on plants. It is known that diesel is a complex mixture of hydrocarbon and it highly phytotoxic to plant species. This implies that tolerance of plants to diesel oil in contaminated soil varied between plant species and within plants species. Additionally, the presence of diesel oil on the soil generally contaminates few meters of soil from the top especially soil surface which in turn result in nutrient depletion and the contaminating process varies throughout the sampled sites. This assertion is in agreement with Adenipekun *et al.*, (2009), who observed that species richness and distribution is likely as a result of the unfavorable environment created by the presence of diesel oil which resulted to decrease in nutrient level and absorption in such away that and plant species responded differently to contamination. The presence of *Cyperus difformis* appears to be predominant in all sampled sites. Their abundance could be attributed to the inherent anatomical, biochemical, physiological and genetic composition which help to enhance their tolerance ability in contaminated environment. The tolerance to diesel oil is a function of the plant species been studied as some plants release specific chelating compounds into the rhizosphere which led to mutualistic relationship between plants and fungi. Fungi associated with some plant roots (mycorrhizae) can be useful in enhancing nutrient availability and decrease in toxicity effects. These findings corroborate with Salt *et al.*, (1995) who reported that the tolerance ability of plants in contaminated site is species dependent. Similar result was reported by Trusby (2003), who suggested that a number of factors are responsible in enhancing the tolerance ability of plant species in polluted environment and these factors are plant based.

5. Conclusion

This study showed that an appreciable amount of diesel oil released daily in the environment has a negative impact on the vegetation.The prevalence of diesel oil on the environmentresulted a drastic reduction in species richness which could lead to loss of vegetationdue to low tolerance ability of plant species.However, the study showed that *Cyperus difformis* possessed an innate tolerance to diesel oil toxicity and should be raised as diesel oil pollution indicator plant.

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	Website: www.ijarbs.com
Quick Response Code	Subject: Plant Sciences
DOI:10.22192/ijarbs.2022.09.12.005	

How to cite this article:
Amadi. N, Chuku S.O and Gbosidom, V.L. (2022). Estimation of the population size of plant species at three generator house vegetations in Rivers State University. Int. J. Adv. Res. Biol. Sci. 9(12): 51-59.
DOI: http://dx.doi.org/10.22192/ijarbs.2022.09.12.005