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Effect of diesel oil on the abundance of West African weed in three stations in Rivers State University.

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Abstract

Pollution due to diesel oil harmful effect is visible on plants through decrease in normal growth of plants, reduction in species richness and induction of chlorosis. To gain understanding into these singularities, three (3) diesel polluted stations with an unperturbed area (control) within Rivers State University were sampled. The dominant species obtained was subjected to vegetation analysis such as species composition, richness, population, diversity and evenness. Results showed that diesel pollution had unembellished negative effect on the immediate plant cover, decrease in species richness and evenness. However, some of the plant species in various sites were experienced chlorosis and stunted growth. The control site showed a rich vegetation cover and increase specie richness. The highest number of species and individual species occurrence was recorded for station 4 as 12 and 448 respectively. Station 1 showed the least in number of species (6) while station 3 showed the least in number of individuals (83). However, within treatment it was observed that station 2 with higher hydrocarbon contentrecorded the highest population of *Tridax procumbens*, *Cyperus difformis*, *Euphorbia hyssopifolia*, *Commelina erecta*, *Portulaca oleracea*, *Boerhavia coccinea* and *Cleome viscosa*, *Cyperus esculenta*,and *Euphorbia hirta*. These plant dominant species in station 2 clearly indicate that tolerance ability of plants in a perturb environment is species dependent, meaning plants with wide ecological amplitude (based on their genetic component) can perform optimally in a polluted environment. These dominate plants in station (2) could be regarded as potential hyperaccumulators which can be considered for phytoremediation purposes.

Keywords: Diesel pollution, diversity, abundance, plant species.

1. Introduction

Environmental pollution was never a problem during the Paleolithic stone Age which is known as the concentration of waste generated man interact was within the carrying capacity of the environment. The materials (pollutants) release into the environment were small in quantity as agents responsible were small (Borsos *et al.*, 2003). Environmental pollution became a topic of concern as a result of explosion in industrial revolution and increase in human population. Man's desire in addressing the challenges threatening his existence in meeting the needs of the fast-growing human population became prominent Babagana *et al.*, (2015) posited that "Man is lost in thought in exploiting the environment in other to meet up the need of the fast-growing population 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 responsibility. According to Ola *et al.*, (2015) "Ignoring responsibilities cannot prevent its consequences. Man's exploitation actions have resulted in the release of different noxious and carcinogenic compounds (waste materials and its by-products) and energy into the environment (soil, water and air).The degradation of the chief components of the environment (soil, water and air) due to emission and release of toxic materials from automobiles, industrial processes and burning of coal has constituted serious problem of pollution in recent times. One of the main environmental degradation problems facing Niger Delta region of Nigeria is the introduction of petroleum hydrocarbon into the environment. This petroleum products are often release into the environment in a quantity much greater than the environment carrying capacity (can dissipate within a short interval).The origin of petroleum hydrocarbon environmental pollution can be traced to Nigeria colonial period when the first oil spillage was recorded at Araromi in Ondo State, in 1908 (Tolulope 2004). The commercial drill of crude by Shell-BP at Oloibiri Bayelsa State in 1956 increased the spate of oil spill. From then till date, oil spillages with its disastrous consequences on the environment has turned out to be part of our heritage.

2. Materials and Methods

2.1 Study area:

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

2.2 Vegetation Sampling:

Plant Species

The sampling of the grassland vegetation was done 5m away from the individual generator stations. Sampling was done as: Station 1 (Medical Sciences RSU), Station 2 (Works Department RSU)Station 3 (Faculty of Agriculture RSU), Station 4 (Unperturbed and unpolluted areas).This sampling was done at latitude and longitude of 4.79709, 6.9799; 4.79741, 6.98316; 4.79072, 6.98162; and 4.79059, 6.98042 respectively using simple sampling technique which is based on standard procedure for quantitative ecological assessment. Transect and quadrat methods were adopted in studying and characterizing the dominant plant species in the studied area. A measurement of 15m 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. The dominant plant species located in each sample unit were characterized by counting and identified using handbook of West

African Weeds (IITA), to obtain phytosociological data.

2.3 Vegetation analysis

Parameters such as species composition, species richness, species population, species diversity and species evenness were observed and calculated.

2.4 Determination of species composition/types

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

2.4.1 Species richness

Species richness data were collected on the sampled sites. Species richness data was obtained by taxonomic identification of the different plant species found in the various generator houses (Sampled site) by physical count. The plants species found were identified with the aid of Tropical Weed Flora (Akobundu *et al*., 2016). Plants used for species richness were above 3cm.
Species richness was determined by using Margalef"s Index (d): $\frac{S-1}{\ln(N)}$

2.4.2 Species population

Species population was determined by mechanical counting and recording the population of individual species in the different sites.

2.4.3 Species diversity

Species diversity (SD) was obtained by calculation using Menhinicks (1964) diversity index.

$$SD = \frac{S}{\sqrt{N}}$$

S = Number of species present N = Total number of individual species.

2.5 Determination of total hydrocarbon content (THC)

The spectrophotometer method was used to determine the Total hydrocarbon content (THC). 1g of the 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 standard bonny light and bonny medium crude graph plotted.

2.6 Determination of total organic content (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 washes 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.

$$\%\ TOC = \frac{\text{Titre value of blank-titre value of sample} \times 0.2 \times 0.3}{\text{Weight of sample}}$$

2.7 Soil cation exchange capacity (CEC)

A measure of 30 mL of 1 part of ammonium acetate solution was added to 5g of oven dried sample and stirred for 15 minutes. The obtained supernatant was then decanted into 1000 mL capacity flask. The process above was repeated twice, and the extracted supernatant was made up to 100 mL by the addition of ammonium acetate solution. The amount of calcium, potassium, sodium and magnesium in samples were determined using Atomic Absorption Spectrophotometer(AAS) (BUCK scientific 200A model).The CEC was obtained and mean soil cation exchange capacity of different location was calculated and expressed in meq/100g of the sample.

2.8 Data analysis

The data generated were subjected to ecological statistical analysis using PAST 4.03. Further validity of significant difference between stations was estimated using Hutcheson.

3. Results

Floristic Composition

Visual observation of the various sample sites showed that diesel pollution had unembellished negative effect on the immediate plant cover causing decrease in species richness and evenness. However, some of the plant species in various sites were experiencing chlorosis and stunted growth. The control site showed a rich vegetation cover, increase specie richness.

Composition and abundance of plant species

Table 1. showed the variation in species composition/abundance in their natural community. The species composition for the different impacted sites and control was observed. Station 4 the control sites recorded more species composition and abundance than the impacted sites. The occurrence of *Kyllinga erecta* was highest at station 1 and 2 with station 3 showing the least. *Tridax procumbens,Cyperus difformis*, *Euphorbia hyssopifolia*, *Eclipta alba*, *Commelina erecta*, *Alternanthera sessillis*, *Phyllanthus amarus*, *Spilanthes filicaulis*, *Cyperus esculenta*, *Euphorbia hirta*, and *Nelsonia canescens* were recorded highest at station 4 (control), while *Portulaca oleracea*, *Boerhavia coccinea* and *Cleome viscosa* were found to be absent. Highest increase in *Portulaca oleracea*was observed in station 3 while, *Boerhavia coccinea* and *Cleome viscosa* were observed in station 2.Within treatment, station 2 recorded the highest in *Tridax procumbens*, *Cyperus difformis*, *Euphorbia hyssopifolia*, *Commelina erecta*, *Portulaca oleracea*, *Boerhavia coccinea* and *Cleome viscosa*, *Cyperus esculenta*,and *Euphorbia hirta*while *Alternanthera sessillis*, was present in station 1 and absent in 2 and 3 and *Spilanthes filicaulis* were absent all stations. The highest number of species and individual species occurrence was recorded for station 4 while station 1 showed the least in number of species (6) and station 3 showed the least in number of individuals (83) table 2.

Table 1: Number of individuals collected for each of the species in the four stations.

S/N	Species	Station 1	Station 2	Station 3	Station 4
1	*Kyllinga erecta*	44	17	5	44
2	*Tridax procumbens*	23	34	14	41
3	*Cyperus difformis*	38	53	21	69
4	*Euphorbia hyssopifolia*	27	32	7	25
5	*Eclipta alba*	19	8	6	28
6	*Commelina erecta*	0	20	6	32
7	*Alternanthera sessillis*	8	0	0	18
8	*Phyllanthus amarus*	0	36	10	29
9	*Portulaca oleracea*	0	0	12	0
10	*Boerhavia coccinea*	0	18	0	0
11	*Cleome viscosa*	0	21	0	0
12	*Spilanthes filicaulis*	0	0	0	18
13	*Cyperus esculenta*	0	18	0	33
14	*Euphorbia hirta*	0	8	2	99
15	*Nelsonia canescens*	0	3	0	12

Table 2: Summary of diversity result.

Diversity indices	Station 1	Station 2	Station 3	Station 4
Total Number of Species	6	12	9	12
Number of Individuals	159	268	83	448
Dominance Index (C)	0.2003	0.1142	0.1497	0.1163
Simpson Index (D)	0.799	0.886	0.850	0.884
Shannon-Wiener Index (H)	1.683	2.297	2.03	2.316
Evenness Index (E)	0.896	0.823	0.845	0.844
Margalef	0.986	1.96	1.81	1.802

Total organic carbon (TOC) was higher in all sample stations with station 2 with the highest value. Similar result was also recorded for TPH (total petroleum hydrocarbon content). Highest increase in CEC (cation exchange capacity) in station 4 as shown in table 3.

Table 3: Summary of soil chemical properties

Soil properties	Station 1	Station 2	Station 3	Station 4
CEC	6.87	6.1	6.63	8.26
TPH	8.1	18.1	11.14	0.001
TOC	7.3	12.9	8.5	1.02

4. Discussion

Floristic Composition

The plant species in the impacted site showed stunted growth and chlorosis symptom. This result tally with the reports of Eze *et al.* (2013), on the study of the effect of petroleum hydrocarbon on the growth of plants. The decrease in plant height could be attributed to the negative impact of the diesel discharged to the immediate environment during the time of application, and the noxious discharge from the generator exhaust may have altered the stability of the environment through reduction in soil aeration and nutrient availability (Abosede, 2013). The effects of these alterations of the environmental ambience led to the over production of reactive oxygen species (ROS) in plants. These ROS appears to be very reactive and toxic and inhibit the optimal performance of plants physiologically, morphologically and anatomically, ROS also cause damage to lipids, proteins, carbohydrates, DNA thereby resulting in oxidative stress (Savajeet and Narendra, 2010).

Composition and Abundance of Plant Species

Natural state of soil is composed of essential minerals and other physical properties design to enhance and support vegetation. This ecological support of soil in enhancing plant optimal performance of vegetation is inhibit due to increase petroleum hydrocarbon discharge into the environment. This petroleum products are often release into the environment in a quantity much greater than the environment carrying capacity (can dissipate within a short interval). The high species richness and composition found in station 4 were envisage since station 4 was free from hydrocarbon pollution. Increase in composition and abundance is due to the favorable/unperturbed environment. However, the study showed low species composition in the impacted stations (1,2 and 3) as compared with station 4. This variation could be attributed to the impact of the hydrocarbon pollution on the plant species present at the impacted station. This assertion is in agreement with Adenipekun *et al.*, (2009) who observed species richness and distribution is likely as a result of the unfavorable environment created by the presence of diesel oil which caused in decrease in nutrient levels and absorption as plant species responded differently to contamination. Baruah and Sarma (1996) from their investigation of the effect of crude oil pollution on species number and crop biomass reported that species number was significant in crude oil polluted soil. Increase in species composition and richness within treatment was recorded for station 2 with high TPH. This could be attributed to the ability of the species to acclimatize and thrive in high TPH soil which makes them a potential phytoremediation species. Plant species may have adopted several internal and external mechanism that which enhance their survival rate in a hydrocarbon polluted soil. The tolerance of diesel oil is a function of the plant species been studied, 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 corroborated with Salt *et al.*, (1995) who reported that the tolerance ability of plants in contaminated site is species dependent.

The increase in TPH content in station 1, 2 and 3 suggest the presence of crude oil products spilled in these stations could be responsible for the observation. The result is in agreement with the findings of Okop and Ekop, (2012) who reported Total petroleum hydrocarbon (TPH) is a mixture of hydrocarbon found in crude oil. This was reported after series of investigation of the level of TPH present in the spilled crude oil at Ikot Abasi in Akwa Ibom State Nigeria. High soil TOC found in the contaminated stations could be ascribed to the droplets of diesel used in running the power unit. This finding is in agreement with Eneje and Ebomotei (2011) who reported a high TOC in crude oil contaminated soil as compared with uncontaminated soil.

5. Conclusion

This investigation tested the potentiality of plant species in diesel contaminated soil. Results clearly indicate that diesel contamination at certain concentration inhibit the optimal performance of plants, especially those plants with low ecological amplitude. The has shown that optimal performance of plants in a perturb environment is species dependent, this is to say that plants having wide ecological amplitude (based on their genetic component) can perform optimally in a polluted environment.

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