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Evaluation of effects of used engine oil on soil properties, abundance and distribution of soil arthropods in Federal Capital Territory (FCT) Abuja, Nigeria

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ABSTRACT: Soil samples were collected in three (3) selected Area Councils i.e. Gwagwalada, Kuje, and Municipal of the Federal Capital Territory (FCT), Abuja, Nigeria. In each Area Council, three replicated pits I, II and III were dug with carbon steel soil core at the depths of 5 cm, 10 cm &15 cm for soil sample collection at mechanic workshops (Sites A and B) and an uncontaminated area (Site C) chosen 40 meters eastward from the study sites. Also, samples of arthropods encountered at the sites were collected. All samples were labeled indicating sites of collection. The samples were analyzed at the laboratory of the Department of Soil Science, Faculty of Agriculture, University of Abuja. Data was analyzed in Randomized Complete Design using SPSS version 18 Software and bar chart. Means were separated with Duncan Multiple Range Test DMRT ($P<0.05$). The result shows a significantly higher negative impact of the contamination on soil properties (pH, moisture. temperature) in the selected Area Councils. It was also established that no arthropod was found on the impacted sites, but a wide range of invertebrates of the class Arachnida, Insecta, and Myriapoda were abundant in the uncontaminated soils. This portrays the deleterious effect of contamination caused by used engine oil on soil properties and the associated soil organisms in the studied area. This calls for remediation of the impacted soil by creating platforms for reuse and recycling of used engine oil and deter the pollution of the soil, water, and the environment in the area.

Keywords: Arthropods, Soil fauna, Abuja, Used engine oil, Soil contamination

Introduction

Natural soils are an amalgam of materials of clastic and biological origin. The soil is an extremely dynamic, complex, and highly heterogeneous complex system that allows the development of an extremely large number of ecological habitats. It is the home of an array of live organisms and performs important functions for the ecosystem (Adhikari and Hartemink, 2015). The soil has significant living components composed of a vast number of species and biomass (Schloter *et al*., 2018). One of the major groups of soil organisms are the arthropods which are very important for the functioning of the soil ecosystems (Adhikari and Hartemink, 2015)

Soil organisms operate within the habitat created in the soil matrix. There are major difficulties in studying soil organisms in situ because the soil is opaque and has a very complex structure, both physical and chemical (Schoonover and Crim, 2015). Besides, the extremely high diversity of soil organisms at a microscopic spatial scale creates obvious problems in evaluating interactions of specific organisms with each other or with their environment. Also, there are major taxonomic difficulties in identifying many components of the soil biota, especially when dealing with organisms of smaller dimensions and probably over 90% of species of microflora and microfauna remain undescribed and unknown (Culliney, 2013). Measurement of the abundance of insects and other arthropods in the soil is still challenging for scientists. This is due to the overwhelming number of arthropods living in the soil. Also, these arthropods collectively comprised over 80% of the total biomass of the terrestrial animals, far outweighing all the other land dwellers such as earthworms, reptiles, birds, and mammals (Cranshaw and Redak, 2013).

Soil arthropods which include insects, such as springtails, beetles, and ants; crustaceans such as sowbugs; arachnids such as spiders and mites; myriapods, such as centipedes and millipedes; and scorpions have the largest number of species and are represented in every well-known habitat, therefore having a very wide habitat and geographical distribution (Sheikh *et al*., 2016). The nature of the soil influences the health of the soil's fauna and movement of gases into and out of the soil. Arthropods are the main components of soil-inhabiting invertebrate fauna and they play an important role in soil nutrient fluxes (Turbe *et al*., 2010; Culliney, 2013). Arthropods have long been recognized as important in the functioning of soil ecosystems and the principal roles played by arthropods in the processes of maintaining soil fertility are enormous.

Used lubricating oil is one of the petrochemicals reported to be a major and most common soil contaminant in Nigeria. It is obtained after servicing and subsequent draining of used oil from automobiles and power generator engines. The oil contains potentially toxic polycyclic aromatic hydrocarbons and heavy metals (Sarma *et al*., 2016). The petroleum hydrocarbons which are the main constituents of the used engine oils spread horizontally on the groundwater-surface and partition into the water, soil pore, air space, and to the surfaces of soil particles (Das and Chandran, 2011). The entry of used engine oil usually alters some of the soil physical (such as soil texture, bulk density, colour, petiole density, and pore space) and chemical (macro and micronutrients) properties resulting in poor aeration, immobilization of nutrients and lowering of pH which is largely responsible for a change in the fertility of the soil (Shukry *et al*., 2013). These alterations may lead to mass mortality of soil macrofauna living in the topmost layers of soil, ultimately disrupting the biological equilibrium of soil (Das and Chandran, 2011).

In Abuja the Federal Capital Territory (FCT) of Nigeria, oils are indiscriminately disposed on the soil by automobile mechanics without knowledge of the impact this hazardous substance has on a wide population of soil fauna. This at most times resultantly poses risk on a large area of land being contaminated. Chin *et al*. (2012) were able to estimate that one liter of used motor oil can pollute up to 3,784 m2 of soil, making it non-productive for farming or plant growth for up to 100 years. This study evaluates the effects of used oil spillage on soil properties as well as the distribution and abundance of soil arthropods in contaminated and non-contaminated sites in FCT, Abuja, Nigeria.

Materials and Methods

Location

The experiment was conducted at the Teaching and Research Farm, of Abuja. The area falls geographically within Latitude 08o 59' N and longitude 07 o 10' E. The soil is well-drained sandy-loam of Alfisols developed over undifferentiated basement complex. The landscape is relatively undulating with short slope length, slope gradient of 10-20%; oriented southwards, and northwards.

Climate and Vegetation

The climate of the area is characterized as moderate to high rainfall with a temperature of about 28-32 °C. The rainfall is between 1100 mm - 1800 mm per annum with abundant sunshine. The vegetation of the area is characterized by woodland, grass, and shrubs; it is a Southern Guinea Savanna.

Sample Collection and Labeling

Soil samples were in three (3) selected Area Councils of FCT, Abuja, Nigeria. Namely: Gwagwalada, Kuje, and Municipal Area Councils. In each Area Council, three replicated pits I, II and III were dug with soil core sampler (carbon steel) 5cm deep at the depths of 5 cm, 10 cm &15 cm for soil sample collection at mechanic workshops (Sites A and B) and an uncontaminated area (Site C) chosen 40 meters eastward from the study sites. The colour of the impacted sites appeared blackish, with some having an oily sheen on the surface, while the uncontaminated sites were well-drained, covered with vegetation and habitation of soil fauna.

The collection was done fortnightly for two consecutive months (May and June 2017). The first core sampler was driven into the soil and the soil collected at the surface of the soil, the second was placed in the same hole (5cm below the ground), and the third sample collected within 10-15 cm of the soil depth. Soil samples were placed in polythene bags and labeled appropriately. Also, samples of arthropods found in leaf litters and crawling out of holes in Site C were collected from the surface of the soil in a marked area of 1 m^2 while no fauna was encountered in all the contaminated stations. The collected arthropods were placed in well-labeled jars of 70 % ethanol for preservation. These samples were taken to the laboratory for further analysis at the Department of Soil Science, Faculty of Agriculture, University of Abuja, Abuja, Nigeria.

Measurement of soil physicochemical properties

Soil Temperature

Temperature readings were taken between 7-9 am, using a mercury-in-bulb thermometer. A pilot hole was dug on the ground and the thermometer inserted with strings attached to hold in position and covered immediately. The temperature was read after a few minutes by marking the point where the mercury has risen and recorded in degree centigrade (°C). This procedure was carried out for all three depths.

Gravimetric water content

25 g was measured out of the collected soil samples and poured into the moisture can and dried in an oven at 105 °C for 24 hours. The samples were allowed to cool before weighing (weight of dry soil) (Bilskie, 2001). Results were reported as % soil water on a dry-mass basis and calculated as:

% Soil water=weight of wet soil-weight of dry soil (g) weight of dry soil x 100

In the laboratory, the remaining soils were air-dried at room temperature (°C), crushed in a porcelain mortar and sieved using a 2 mm and 0.8 mm sieves. They were stored in polythene bags and labeled appropriately for subsequent analysis**.**

Soil pH

The pH meter was first calibrated using a pH7 buffer solution and adjusted with buffer solutions 4.0 and 9.2 following Kulasekaran *et al*. (2015) procedure. The soil was weighed and transferred into 100 ml beaker, 20 ml distilled water was added and stirred with a glass rod. This suspension was allowed to stand after stirring for 15 minutes. The electrode was then immersed in the suspension which electronically displayed the pH value.

Soil organic matter

The Wakley-Black (2019) procedure was used in this determination. This procedure measures active or decomposable organic matter in the clay. It is also based on the oxidation of organic carbon in the soil by treatment with the hot mixture of $K2Cr2O7$. 1.0 g of clay sample was weighed in duplicate and transferred to 200 ml Erlenmeyer flask. 10 ml of 0.1667M $K2Cr2O7$ solution was pipetted accurately into each flask and swirled gently to disperse the clay. 20 ml of conc. $H2SO4$ using an automatic pipette was added directing the stream into the suspension. The flask was immediately swirled gently until soil and reagent were properly mixed. The mixture was spun more vigorously for one minute. The beaker was allowed to stand for 30 minutes. Then 100 ml of distilled water was added after standing for 30 minutes 3-4 drops of the indicator were added and then the solution was titrated to an endpoint with 0.5 N ferrous sulphate solution.

As the endpoint was approached, the solution took on a greenish cast and then changed to dark green. At this point, ferrous sulphate was added drop-wisely until the colour changed sharply from blue to red in reflected light against a white background. A blank titration in the same manner without the clay sample but following the same step to standardize the potassium dichromate was made.

Statistical Analysis

The statistical assessment was done using Microsoft Excel and R-statistical software. Statistical differentiation was determined using the Randomized Complete Block Design and means were separated with Duncan Multiple Range Test at 0.05 level of significance. Also, a bar chart was used in the presentation of the class of arthropods encountered at the study sites.

Results

The effect of used engine oil on the sampled stations in the three selected Area Councils on soil properties was presented in Table 1. The highest soil pH of 7.91 was recorded at Kuje, which was significantly different ($p<0.05$) from Gwagwalada with the lowest pH of 5.80 obtained from the uncontaminated site. In May, the highest moisture content of 18.23 % was recorded at Gwagwalada which was significantly different ($p<0.05$) from the lowest moisture 4.30 % experienced at Kuje. Kuje also had the lowest moisture content in the second month (June), while the highest reading (16.95 %) was at Municipal stations. Gwagwalada had the highest temperature of 31.3°C and the lowest temperature of 24.1°C was recorded in stations at Municipal Area Council in May. On the other hand, in June, the highest temperature (29.1°C) was observed at Kuje and lowest (24.0°C) at Gwagwalada Area Council. The highest organic matter obtained was 2.7 % at Municipal and the lowest (1.49 %) at Gwagwalada Area Council.

Table 2 shows the interactive effect of sampled stations and depths on soil properties. Kuje showed the maximum pH (8.2) at depth 10 cm, while the minimum pH value of 5.59 was recorded in Municipal uncontaminated site. The soil moisture for May was highest (18.5%) in Gwagwalada uncontaminated soil and lowest (2.4 %) at depth 10 cm in Kuje Area Council while June had moisture content with the highest value (16.8 %) was obtained from the uncontaminated soil samples collected in Gwalgwalada and lowest value of 3.2% at depth 5 cm in Kuje. The temperature had the maximum reading of 32°C at depth 15 cm in Gwagwalada station and lowest reading of 24.5°C in Gwagwalada station in May. Also, in June, the highest temperature reading of 29.7°C was recorded at depth 5 cm in Kuje and Gwagwalada had the lowest (24.2°C) temperature reading. Organic matter was highest with 3.10 % at depth 10 cm in Kuje and lowest of 1.30 % at 15cm depth in Kuje station.

Table 3 shows the comparison of the interactive effects of sample stations in the Area Councils and sites on soil properties. The highest pH (8.28) was recorded at Kuje, Site III, and lowest (5.84) in Municipal uncontaminated site. In May, moisture recorded the highest value of 18.22 % in the uncontaminated site in Gwagwalada and the lowest value of 1.6 % in Site II in Kuje while in June the highest (17.01 %) moisture was obtained in the uncontaminated site in Municipal Area Council and lowest moisture content of 4.8 % in Site I in Kuje Area Council. In May, the temperature had a maximum record of 32°C in Gwagwalada Site II and the lowest value of 23°C at Kuje, Site II. Also, in June, Kuje had the highest temperature reading of 31.2°C in Site II and the lowest temperature (24.4°C) in soils collected from the uncontaminated site in Kuje Area Council. Organic matter of 2.9 % recorded in Kuje, Site III was the highest while the lowest value (1.50 %) was recorded in Gwagwalada, Site II.

Table 1: Effects of used engine oil contamination on soil properties at the Federal Capital Territory (FCT), Abuja

Station	pH	Moisture (%)		Temperature (°C)		Organic matter (%)
		May	June	May	June	
Gwagwalada	7.21^{b}	11.43^{b}	7.80^{b}	31.30^{a}	27.11^{b}	1.70^{b}
Uncontaminated	5.80^{a}	18.23^{a}	16.10^{a}	24.23^{b}	24.00^{c}	1.49^{c}
Municipal	7.21^{b}	7.38^{bc}	9.10^{b}	25.80^{b}	29.00^{a}	2.70^{a}
Uncontaminated	5.85^{a}	17.50^{a}	16.95^{a}	24.11^{b}	24.10^{c}	1.50^{c}
Kuje	7.91^{c}	4.30^{c}	6.30^{b}	27.60^{b}	29.10^{a}	2.30^{ab}
Uncontaminated	5.88^{a}	17.90^{a}	16.56^{a}	24.51^{b}	24.12^{c}	1.52^{c}

Means in the same column with different alphabet are significantly different P< 0.05

Table 2: Interactive effects of sampled stations and depths on soil properties at the Federal Capital Territory (FCT), Abuja

Station (depth)	pH	Moisture (%)		Temperature (°C)		Organic matter (%)
		May	June	May	June	
Gwagwalada (5cm)	7.22^{ab}	9.96^{bc}	5.40^{c}	30.70^{abc}	27.80^{abc}	2.00^{b}
Gwagwalada (10cm)	7.19^{ab}	14.76^{b}	9.10^{c}	31.20^{ab}	26.80^{bc}	1.60^{bc}
Gwagwalada (15cm)	7.21^{ab}	9.56^{bc}	8.90^{c}	32.00^{a}	26.70^{c}	1.50^{bc}
Uncontaminated	5.78^{c}	18.52^{a}	16.88^{a}	24.50^{c}	24.28^{c}	1.48^{bc}
Municipal (5cm)	6.76^{b}	12.22^{bc}	8.60^{c}	25.00^{d}	29.20^{a}	2.90a
Municipal (10cm)	7.65^{ab}	5.00^{bc}	12.60^{b}	26.50^{cd}	28.70^{ab}	2.80a
Municipal (15cm)	7.21^{ab}	4.93^{bc}	6.00^{c}	25.80^{d}	29.20^{a}	2.40^{ab}
Uncontaminated	5.59^{c}	17.99^{a}	16.54^{a}	24.70^{c}	24.32^{c}	1.45^{bc}
Kuje (5cm)	7.44^{ab}	7.19^{bc}	3.20^{c}	27.00^{bcd}	29.70^{a}	2.60^{bc}
Kuje (10cm)	8.20^{a}	2.40^{c}	6.20^{c}	26.80^{bcd}	29.50^{a}	3.10a
Kuje (15cm)	8.11^{a}	3.32^{c}	9.60^{c}	28.80^{abcd}	28.70^{ab}	1.30^{c}
Uncontaminated	5.89^{c}	17.56^{a}	16.49^{a}	24.65^{c}	24.57^{c}	1.48^{bc}

Means in the same column with different alphabet are significantly different P< 0.05

Table 3: Comparison of interactive effects of sampled stations and sites on soil properties

Station	pH	Moisture (%)		Temperature(°C)		Organic matter (%)
		May	June	May	June	
Gwagwalada I	7.34^{ab}	14.92^{ab}	5.00^{c}	31.00^{a}	27.50^{b}	1.90^{a}
Gwagwalada II	7.64^{ab}	5.62^{bc}	8.40^{bc}	32.00^{a}	27.33^{b}	1.50^{b}
Gwagwalada III	6.63^{ab}	13.75^{b}	10.00^{b}	30.80^{a}	26.50^{b}	1.80^{a}
Uncontaminated	5.85^{c}	18.22^{a}	16.88^{a}	24.00^{c}	24.50^{c}	1.51^{b}
Municipal I	7.57^{ab}	5.21^{bc}	10.80^{b}	25.30^{bc}	30.00^{a}	2.80^{a}
Municipal II	7.36^{ab}	9.56^{bc}	9.20^{b}	26.20^{bc}	29.80^{a}	2.60^{a}
Municipal III	6.70^{b}	7.37^{bc}	7.20^{b}	25.80^{bc}	27.20^{b}	2.70^{a}
Uncontaminated	5.84^{c}	18.00^{a}	17.01^{a}	24.11^{c}	24.44^{c}	1.60^{b}
Kuje I	7.36^{ab}	4.24^{bc}	4.80^{c}	30.50^{a}	29.70^{a}	2.10^{a}
Kuje II	8.10^{a}	1.56^{c}	7.10^{bc}	29.20^{ab}	31.20^{a}	2.00^{a}
Kuje III	8.28^{a}	7.11^{bc}	7.00^{bc}	23.00^{c}	27.00^{b}	2.90^{a}
Uncontaminated	5.88^{c}	17.99^{a}	16.99^{a}	24.08^{c}	24.42^{c}	1.57^{b}

Means in the same column with different alphabet are significantly different $P < 0.05$

Arthropods distributions in the Area Councils were reported in Figure 1. In May, the highest classes of arthropods identified across the locations were of the Class Insecta. Gwagwalada experienced the highest number of the insect in May while the lowest number of the insect was recorded in Kuje Area Council in June. Also, the Class Myriapoda was highest in Gwagwalada in June while the least occurred in May in Municipal Area Council. The Arachnids were relatively low in number in the sampled stations in the three selected Area Councils. The highest number of Arachnids occurred in May in Municipal Area Council while none was encountered in June in Kuje Area Council.

Table 4 shows the abundance of the Phylum Arthropoda in the sampled stations in the selected Area Councils (i.e. Gwagwalada, Kuje, and Municipal) of the FCT, Abuja. The arachnids encountered include wolf spider, tick, spider and scorpion while termite, praying mantis, beetle, ant, cockroach, cricket, grub worm, termite eggs, dragonfly, jumping bristles and caterpillars of the Class Insecta were obtained in abundance compared to the other Classes in the Phylum Arthropoda. The myriapods constitute the collections of arthropods next to the insects in terms of number. The myriapods encountered in the stations include; earthworms, millipedes, and centipedes. The highest number of arthropods was encountered in May in most of the stations.

Table 4: Distribution of Arthropods in the Sampled Stations in FCT, Abuja

Classes	Arthropods	No of species/Area Council/Months					
		Gwagwalada		Municipal		Kuje	
		MAY	JUNE	MAY	JUNE	MAY	JUNE
Arachnida	Wolf Spider	-	-	-	2	2	-
	Tick	1	-	-	-	-	-
	Spider	1	-	7	-	-	-
	Scorpion	-	-	1	-	-	-
Insecta	Termite	84	7	-	4	26	-
	Praying Mantis	-	-	-	1	-	-
	Beetle	2	-	44	1	3	1
	Ant	16	-	9	18	5	2
	Cockroach	5	5	-	-	4	-
	Cricket	3	-	-	-	1	1
	Grub Worm	1	-	2	-	-	1
	Termite Eggs	Many	-	Many	-	Many	-
	Dragon fly	-	1	-	-	-	-
	Jumping Bristletails	-	2	-	-	-	-
	Caterpillar	-	3	1	15	-	-
Myriapoda	Earthworm	4	11	-	4	17	9
	Millipede	17	19	3	2	1	-
	Centipede	6	16	6	-	-	1
	Unidentified eggs	-	-	1	1	-	-
Total		**157**	**65**	**74**	**48**	**59**	**15**

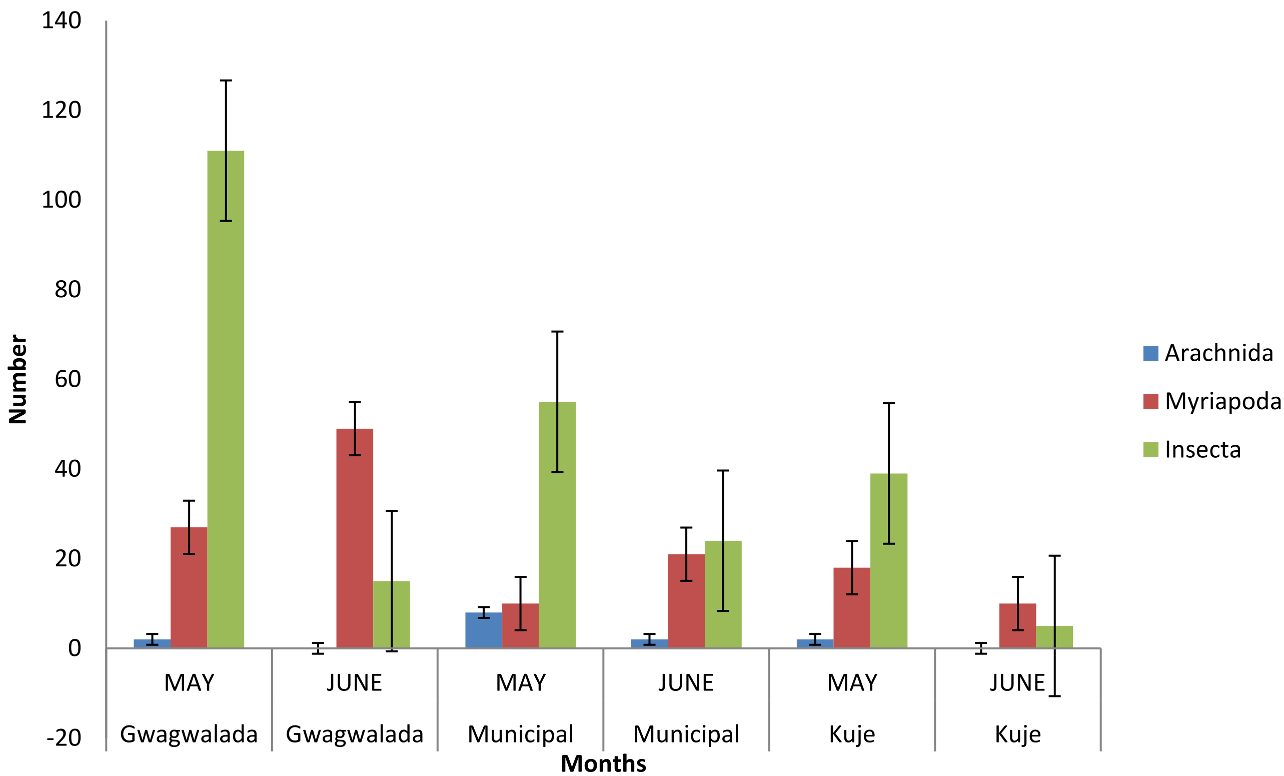

Figure 1: Arthropods distribution in Sampled Stations at the FCT, Abuja

Discussion

The study evaluated the effects of used engine oil on the abundance and distribution of soil arthropods in FCT, Abuja. It was deduced that the impacted soil had no fauna while living organisms existed in the uncontaminated soil. This portrays the deleterious impact of contamination caused by the presence of used engine oil in the sampled stations and corroborates earlier reports on the impact of used engine oil pollution on soil aeration that can sustain the growth of flora and fauna (Das and Chandran, 2011; Chin *et al*., 2012; Shukry *et al*., 2013). Used engine oil also pollutes the environment if they are not recycled or disposed of properly. The abundance of un-recycled engine oil in the study area impacted negatively the soil and increase contamination of the soils in all the Area Councils. This shows the importance of establishing a clean environment that will support soils having good physicochemical characteristics that can support the inhabitation of living organisms (Schoonover and Crim, 2015).

Gwagwalada recorded higher moisture in May than in June, this was due to the erratic rainfall pattern at the start of the raining season while in the other two locations, and it followed a normal trend. This is under the annual report by Nigerian Metrological Agency (NIMET) in 2017 that predicted the beginning and the end of the season was characterized by the frequent occurrence of wind storms accompanied by thunderstorms and lightning followed by strong wind and rainfall of high intensity.

Soils with smaller particles (silt and clay) have a larger surface area than those with larger sand particles and a large surface area that allows the soil to hold more water. In other words, a soil with a high percentage of silt and clay particles, which describes fine soil, has a higher water-holding capacity. Organic matter percentage also influences water-holding capacity. As the percentage increases, the water-holding capacity increases because of the affinity organic matter has for water (Saljnikov *et al*., 2013; Al-Kaisi *et al*., 2014).

However, the interactive analysis showed that Kuje (Site II and III) had the highest pH from the interactive analysis. Kuje at a depth above 10 cm had the highest pH (increase in alkalinity) which showed that they had the highest contamination due to the presence of Calcium Carbide (CaCa3), which can also lead to the contamination of underground water. Calcium Carbide (CaC_2) is usually used in industrial acetylene production for welding tools and chemical synthesis (Ihejirika *et al*., 2014). It is also used in caving fuel acetylene, largely used carbide is usually left by some cavers anywhere in caves where the recharging of gas generators takes place and over the year this can result in substantial accumulation of such wastes such as carbide dumps (Ferronato and Torretta, 2019). Research has shown that Calcium Carbide can lead to the death of all hatched larvae and also all microorganisms that can support plant growth hereby making the soil unfavourable to plants and animals growing within an area (Semikolennykh *et al*., 2012). The absence of living organisms in the impacted soil in the three Area Councils confirmed with the deleterious effect of heavy metals on soil (Sarma *et al*., 2016). Besides, Semikolennykh *et al*. (2012) also ascertained that used Calcium Carbide waste is highly toxic but loses its toxicity within a short period.

Organic matter of the soil samples was very low, which is generally common in tropical environments, which is merely due to the effect of high temperature that encourages high microbial activities that aid decomposition. It is generally assumed that organic compounds and Soil Organic Matter (SOM) have a faster turnover in tropical than temperate soils due to the enhanced decomposition under the higher moisture and temperature regimes of the Tropics (Karmakar *et al*., 2016).

In May, Class Insecta was dominant across all the sites. This finding corroborates the fact that the Class Insecta is the most abundant Class of Arthropods. Entomologists estimate that over 800,000 insect species have been named and described. Insects represent more than half (about 53 %) of the 1.5 million species of living organisms known to Science (Cranshaw and Redak, 2013).

A swarm of migratory locusts may contain up to 10 billion individuals, cover an area of several thousand hectares, and have total biomass of over 30,000 metric tons. In the tropics, ants are the most pervasive and diverse of all animal species. Colonies of driver ants (Dorylus sp.) on the African savannah may contain 20 million individuals (NC State, 2015). Notably no single ecological or physiological attribute can account for this unparalleled success; the insects do have a unique combination of characteristics which, as a whole, have given them an unusual survival advantage. The attributes of insects such as an exoskeleton, small body size, the ability to fly, a high reproductive potential enhance their adaptability in an ever-changing environment (Meyer, 2016).

Conclusion

The negative impact of the absence of faunas in soils contaminated with residue of used engine oil established in this study and the presence of faunas in the uncontaminated stations in the in FCT Abuja portrays the deleterious effect of contamination on the survival of soil organisms. This calls for remediation of the impacted soil to allow the growth of soil macro and microorganisms in the ecosystem. This can be achieved by creating platforms for reuse and recycling of used engine oil and also aid the reduction of pollution of soil, water, and the environment in the study area. Also, the National Environmental Standards and Regulations Enforcement Agency (NESREA) which is the major Nigerian environmental agency in charge of managing the healthy environment, should provide a comprehensive strategy grounded on Standard Operation Procedures (SOPs) that will create a model for collecting, disposing and recycling of used engine oil in a manner that will be safe, efficient, environmentally sound and cost-effective for Nigerians.

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