Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 02, pp.46056-46059, February, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

ANALYSIS OF PHYSIOCHEMICAL PARAMETERS OF HYDROCARBON CONTAMINATED SOIL

***Gayathiri, E., Bharathi, B., Selvadhas, S. and Natarajan, S.**

Department of Plant Biology and Plant Biotechnology, G.S.Gill Research Institute, Guru Nanak College, Chennai - 600 048

ARTICLE INFO

Article History:
Received 24th November, 2016
Received in revised form
06th December, 2016
Accepted 19th January, 2017
Published online 28th February, 2017

Key words:

Hydrocarbon, Soil,
pH, Micronutrients,
Macronutrients.

ABSTRACT

Contamination of soil by hydrocarbons is becoming prevalent across the globe. This is probably due to heavy dependence on petroleum as a major source of energy throughout the world, rapid industrialization, population growth and complete disregards for the environmental health. The effects of hydrocarbon pollution on soil physical and chemical properties were investigated by using different methods. Physical analysis like Texture, pH, Lime status and EC were performed and concentration of Micro and Macronutrients were analyzed. The results revealed that organic carbon increased with increase in pollution while nitrogen, potassium and phosphorusdecreased with increase in pollution. The pH became more basic as pollution decreases. This result reveals that the polluted soil when compared with the control (soil from unpollutedfarmland) is unsuitable for agricultural activities as full remediation has not taken place except remediation can be hastened. This result reveals that the polluted soil is unsuitable for agricultural activities. A wide range of bioremediation strategies is being developed to treat contaminated soil.

Citation: Gayathiri, E., Bharathi, B., Selvadhas, S. and Natarajan, S. 2017. "Analysis of physiochemical parameters of hydrocarbon contaminated soil", *International Journal of Current Research*, 09, (02), 46056-46059.

INTRODUCTION

There is growing public concern as a widevariety of toxic chemicals are beingintroduced inadvertently or deliberatelyinto the environment. Petroleumhydrocarbons are one common example ofthese chemicals, which enter theenvironment frequently and in largevolumes through numerous routes. Petroleum hydrocarbons come into theenvironment through accidents, spills orleak, urban input, industrial releases andcommercial or domestic uses (Ou *et al*., 2004; Wang and Stout, 2007). Soil polluted with organic compounds such as hydrocarbon (HC) products is an important environmental problem around the world (Erika Mendez *et al*., 2011). The term hydrocarbon has been used to petroleum complex mixtures in which there are hundreds of organic compounds ranging from light, volatile and short - chained compounds to heavy, long - chained and branched compounds (Wong *et al*., 1997). Some researchers have been interested in studying how HC presence affects soil matrix in its physical and chemical properties (Martinez *et al*., 2001) and Munoz *et al*. (2007). Studied properties include texture, moisture content, density, soil organic matter, pH, electrical conductivity and cation exchange capacity, among others. Currently, about 80% of land are polluted by products of petroleum origin

Corresponding author: Gayathiri, E.
Department of Plant Biology and Plant Biotechnology, G.S.Gill Research Institute, Guru Nanak College, Chennai 600 048

(hydrocarbons, solvent, etc.) used as an energy source in the oil industry, as well as chemicals (Marinescu *et al*., 2001). There are a variety of pollutants affecting topsoil and subsoil, such as fuel and oil products, hydrocarbon residues, crude oil, other products resulting from the operation (saturated and unsaturated aliphatic hydrocarbons, and the monocyclic and polyclic aromatic) (Engelking, 2000). Soil and water represent the first lines of recipients of oil pollution. Ground water contamination by crude oil therefore is becoming an increasing sensitive issue in India because most of the water supply is derived from shallow and unconfined aquifers. Furthermore, contamination of land is of paramount importance to man in that it is on this portion of the earth that the anvil of man's existence and activities lie. Oil pollution has deleterious effect on plant growth, soil macronutrients, microorganism and the terrestrial ecosystem in general (Osuji, 2002). Pollution results when a change in the environment harmfully affects the quality of human life including effects on animals, microorganisms, and plants. Pollution has been defined as the presence in significance amounts of an extraneous material which may be solid, liquid or gas in a particular location (SPDC, 1987). The contamination of the environment (mainly terrestrial and aquatic) by crude oil is therefore referred to as oil pollution and it is estimated that 80% of oil pollution is as a result of spillage (Odu, 1977). Spillage of petroleum hydrocarbons either byaccident or vandalization causes significant environmental pollution (Mukherjee and Bordoloi, 2010). Crude petroleum oil and its derivativesreleased in the environment either accidentally order liberately pose problems of increasing magnitudethroughout the world (Okoh and Trejo-Hernandez, 2006). Oil spillage affects the soil ecosystem and environment that are completelyaquatic. It is known that oil sometimes floats on water surfaces where it is dispersed toshorelines by wind and wave action, alsoaffecting the soil environment (Onojake and Osuji, 2012). However, because the concentrations of macronutrients are well below those recommended for agriculture, it could be inferred that the presence and or levels of petroleum hydrocarbons has impacted negatively or reduced the fertility status of the affected area. Consequently, land use for agricultural purpose can be affected. In addition to affecting the agricultural productivity of the soil; prolonged retention of these hydrocarbons can adversely affect both surface and subterranean water quality is reported. Bioremediation provides a good cleanup strategy for some types of pollution involving hydrocarbons in petroleum spilled soils. Thus, the main purpose of the present study is to analyze physic chemical parameters of hydrocarbon contaminated soil to speed up the natures of attenuation pathway with the help of microbial degradation.

Fig.1a **Fig.1b** **Fig.1c**

Figure 1. Soil Sample Collected from different soil polluted sites

MATERIALS AND METHODS

The 200 gm of soil samples were collected from different hydrocarbon polluted area situated at different location of the town. These locations were around Salem (district). The physiochemical characters such as the pH of the soil were determined by using Potentiometric method. The electrical conductivity of the soil was determined by the conductivity of the salts present in the soil by EC meter. The Macronutrient such as Nitrogen by Alkaline Permanganate method (Subbiah and Asija, 1956). Phosphorous by using Olsen's method. (Olsen *et al*., 1954 and Watanable and Olsen 1965), Potassium by Boiling Nitric acid method using Flame Photometer. Micronutrients are analysed using Atomic Absorption Spectrometer Standards. Fig 1shows Diesel Polluted site, Kerosene polluted site and Crude polluted oil.

RESULTS

Physicochemical Analysis

The physicochemical characteristics of the soil is shown in Table 1 are substantiated below, the weight of the DS1 305 gm, KS1 215 gm, and CS1 475gm. The Texture of DS1 is Sandy Loam and KS1 and CS1 were Loamy Sand. (Fig.1) The pH value of soil sample in Control contains pH 7.7, KS1 and CS1 contain pH 7.1 and DS1 contain pH 7.4. The electrical conductivity of the Control sample is 0.5 kg/Ac, DS1 0.4µs/cm, KS1 contain 0.4 µs/cm, and CS1 contain 0.6µs/cm. (Table 1; Fig: 2)

Macronutrients of the Polluted Soil

The soil containing macronutrients are Nitrogen, Phosphorus and Potassium. The Control soil sample contains an amount of Nitrogen 70 kg/Ac. The high amount of Nitrogen was present in the Soil sample KS1 with 59 kg/ac, DS1 with 73 kg/ac and CS1 with 67 kg/ac. Phosphorus content of the Control soil sample was 7 kg/ac, DS1with 8 kg/ac, KS1 with 4 kg/ac and CS1 with 7 kg/ac. The Potassium content of the Control soil sample was 104 kg/ac, DS1 and KS1 with 86 kg/ac, and CS1 with 78 kg/ac. (Table.1, Fig. 3)

Micronutrients of the Polluted Soil

The micronutrient content of the Ferric, Manganese, Zinc and Copper in Diesel, Kerosene and Crude oil contaminated Soils were analysed. From the present investigation, the Ferric Content in control was 5.6ppm, KS1- 4.8ppm, DS1- 8.0ppm, and CS1 -8.4ppm. Manganese content in control was 2.6ppm, KS1, and CS1 was 2.4ppm, and DS1- 2.0ppm. Zinc content in control was 1.0ppm, KS1 - 0.6ppm, KS1 -1.6ppm, and DS1- 1.2ppm. Copper content in control was 1.0ppm, KS1-1.0ppm, CS1- 0.8 ppm, and DS-1 -0.6ppm respectively. (Table.1, Fig: 4)

Table 1. Soil Sample Analysis in Hydrocarbon contaminated soil

Soil sample		DS1	KS1	CS1
Weight (gm)		305	215	475
Texture		SL	LS	LS
Lime status		M	N	M
P^h		7.4	7.1	7.1
Electric conductivity		0.4	0.4	0.6
Macro nutrients kg/ac	Nitrogen	73	59	67
	Phosphorus	8	4	7
	Potassium	86	86	78
Micro nutrients content (ppm)	Ferrous	8.0	4.8	8.4
	Manganese	2.0	2.4	2.4
	Zinc	1.2	0.6	1.6
	Copper	0.6	1.0	0.8

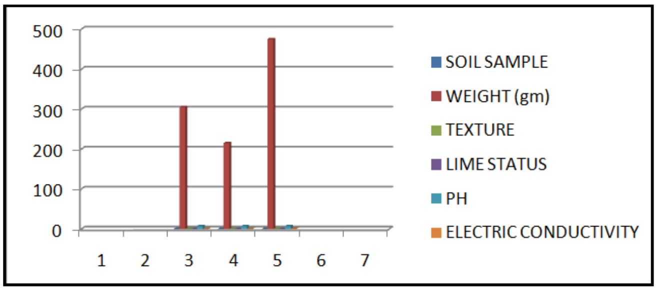

Fig. 2. Sample Analysis

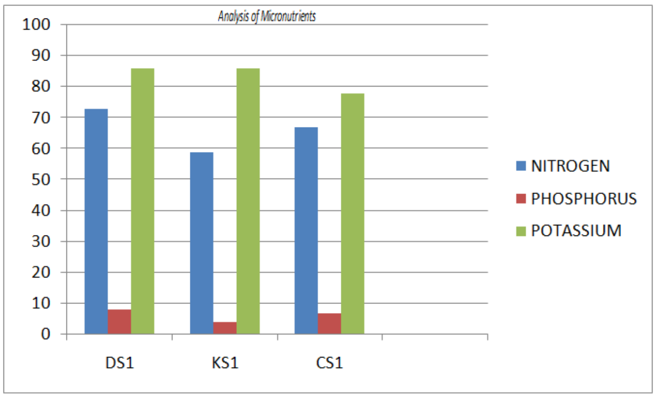

Fig. 3. Analysis of Micronutrients in Hydrocarbon contaminated soil

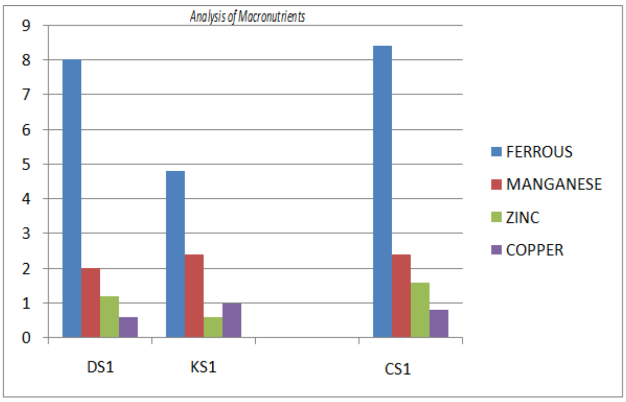

Fig. 4. Analysis of Macronutrients in Hydrocarbon contaminated soil

DISCUSSION

The physiochemical characters of the polluted soil were studied in which soil sample belongs to sandy loam and loamy sand soil. Carbon is most important for the growth of any living organism; it helps to stimulate the growth. 50% of carbon is needed for the growth of microbial cell. The bacteria need macronutrients like nitrogen, phosphorous and potassium for effective degradation of the hydrocarbons, this probably accounts for the microbial count in which DS1 and CS1 had the highest count (224 × 10^{-5}cfu/ml, 248 × 10^{-5}cfu/ml). KS1 had the least bacterial count (80 × 10^{-5}cfu/ml). This is because not all microorganisms can utilize hydrocarbon as substrate for growth. Furthermore, the presence of hydrocarbon can inhibit the growth of many microorganisms. The optimum nutrient balance required for hydrocarbon remediation is Potassium: Nitrogen: phosphorous: respectively 100:10:4. The nitrogen, phosphorous and potassium of the collected polluted soil sample ranged from the nitrogen of 59 to 73 kg/acre, Phosphorous of 4- 8 kg/acre, and potassium of 78- 86 kg/acre. They were also differing in the micronutrient in the soil. The micronutrients of the soil need at least 0.5% of their concentration in the soil.

The pH values of the impacted soils lies within the acidic range and may not support the growthof most crops that thrive on alkaline soil, this may lead to loss of macro minerals needed forplant growth. Thus, acidification of soil depletes important nutrient elements such as potassium, calcium and magnesium (Onyeike *et al.*, 1999). Liming is therefore necessary to de-acidity the affected mat layerof soils for such soil to accommodate plant life. pH also affects the solubility and availability ofsoil constituents which may affect biological activity in the soil (Vadimira, 2002). The total nitrogen level decreasedwith increased pollution. The findings of present investigationsagrees with the findings (Akubugwo *et al.,* 2009) on the same polluted area, wheretotal nitrogen level was more elevated inthe impacted soil, compared with thecontrol. The increase in total nitrogen levelin the control sample compared with thepolluted area could be as a result of theactivities of nitrogen-fixing bacteria andother microbes associated withdecomposition of organic matters, whichmight be inactivated in the polluted area. Osuji and Onojake (2006) attributed this to the metabolic processesfollowing oil spillage that facilitatesagronomical addition of organic carbonfrom petroleum hydrocarbon by reducingthe carbon mineralizing capacity of themicroflora. It has been reported Available micronutrients (Pb, Mg, K, Zn, Cu, Mn, Fe) was observed in higher amount in contaminated samples than uncontaminated samples. According to prior investigations, it can be concluded that crude oil contamination generally elevates the heavy metal content of the soil. Therefore, crop cultivated on such polluted location can cause of bio-accumulation of heavy metals in the population (Adesina O. Gabriel and Adelasoye A. Kasali, 2014). Though, this study confirms that pollution by crude oil developed some hydrocarbon degrading populations of microorganisms. It has been stated adjustment of carbon/nitrogen/phosphorus ratios bythe addition of nitrogen and phosphorus in the form ofoleophilic fertilizers including paraffinized urea havebeen shown to stimulate microbial organisms intoutilization of crude oil in different ecosystems, (Atlas and Bartha, 1972). Previous studies on crude oil pollution in soil had revealed its adverse effects on soil productivity udo *et al*. (1975) and Okpowasil *et al*. (1990). In the present investigation the main aim was to investigate as many as physiochemical parameters of DS1, which could be beneficial for biodegradation in soil environment.

Conclusion

In conclusion, the physiochemical parameter of soil reveled that there were significantly high levels of diffused petroleum hydrocarbon in the area. From the findings of results the High organic carbon, Total Nitrogen, Phosphorous and Potassium concentrations, Low soil fertility index, Alkaline nature and Low moisture content were high due to presence of high level of hydrocarbon. Furthermore, proper and effective monitoring of the hydrocarbon level is recommended, while a synergetic bioremediation approach should be the first steps in the reclamation process. The finding of the present study could be utilized for the standardization of bioremediation protocols. The growth and activity of the microorganism in such sites could be enhanced by increasing moisture content and incorporating surfactant in the soil, which may further increase bioavailability of hydrocarbons in the soil for microbial degradation.

REFERENCES

Adesina O. Gabriel and Adelasoye A. Kasali, 2014. Effect of crude oil pollution on heavy metal contents, microbial population in Soil, and Maize and Cowpea growth. *Agricultural Sciences*, Vol. 5. pp 43-50.

Akubugwo, E.I., Chinyere, G.C., Ogbuji, G.C and Ugbuagu, E.A. 2009. Physiochemical property of Enzyme activity in a refined oil contaminated

Atlas, R.M., Bartha, R. 1992. Hydrocarbon biodegradation and oil spill bioremediation, In marshal KC (Ed) *Advances in Microbial Ecology,* 12,287-338.

Engelking, P. 2000. Pollution, Microsoft Encarta Online Encyclopedia, contamination soil in Isuikwuato L.G.A., Abia State, *Nigerian society for Environmental Biology*, 2: 79-84.

Erika mendez *et al*., 2011. Effect in the physical chemical property of Gleysol soil after an Electro kinetic treatment in the presence of surfactant Triton- X 114 to remove hydrocarbons. *International Journal of Electrochemical Science.,* 6: 1250-1268.

Marinescu, M., Toti, M., Tanase, V., Plopeanu, G., Calciu, I., Marinescu, M., 2001. The effects of crude oil pollution on physical and chemical characteristics of soil. *Research Journal of Agricultural Science,* 43(3), 125-129.

Mukherjee, A.K. and N.K. Bordoloi, 2010. Bioremediation and reclamation of soilof petroleum hydrocarbon and heavy metal content of soil affected by Ebocha oil spillage in Niger Delta, Nigeria. *Journal Environ Mgt.,* 79: 133-139.

Muñoz A. - Chaves, P. Mancilla and J. E. Rodríguez - Páez, Rev. Acad. Colomb. Cienc. 31 2007. 537 - 544.

Odu, C.T.I. 1977. Microbiology of soils contamination with petroleum hydrocarbons ‘‘Natural rehabilitation and reclamation of soil affected’’. *Inst. Petrol. Technol. Publ.,* 1, 77 – 105.

Okoh, A.I. and M.R. Trejo-Hernandez, 2006. Remediation of petroleum hydrocarbon polluted systems: Exploiting the bioremediation strategies. *Afr. J. Biotechnol*., 5: 2520-2525.

Okpowasili, G. C, Odokuma, L.O., 1990. Effect of Salinity on Biodegradation of oil spills dispersants. Waste Manage. 10(12) 141-146.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean.L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of Agricultural Circ. Pp. 939.

Onojake, M.C. and Osuji, L.C., 2012. Assesstment of the physio chemical properties of hydrocarbon contaminated soil. *Archives of Applied Science Research*, 4: 48-58.

Onyeike, E.N. and Ogbuja, 1999. S.I. *Journal of Applied Science and Environment Management*., 3: 23-28.

Osuji, L. C. and Onojake, C. M. 2006. Field Becomaissance and Estimation of soil in Isuikwuato L.G.A., Abia State, *Nigerian Society for Environmental Biology*, 2: 79-84.

Osuji, L.C. 2002. *Africa Journal of interdisciplinary study*. 3: 11-17.

Ou, S.M., Zheng, J.H., Richardson, B.J., Lam, P.S.K. 2004. Petroleumhydrocarbons and polycyclic aromatic hydrocarbons in the surficial sediments of Xiamen Haror andYaun Dan lake, China Chemosphere 56:107-112.

Report: SPDC, Shell Petroleum Development Company, 1987. A report on Environmental Pollution. Warri, Nigeria.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science*, 25 (8): 259-260.

Udo, E. J., Fayemi, A. A., 1975. The effect of oil pollution of soil on germination, growth and nutrient uptake of Corn. *J. Environ. Qual.,* 4: 537-540.

Vadimira, B. 2002. Bioremediation technologies for treatment of crude oil polluted soils in refinery play in Slovnatt Republic. 478. DOI: 10.1007/s11356-010-0391-2.

Wantanable F.S. and Olsen, S.R. 1965. Test of an ascorbic acid method for determining phosphorus in water and $NaHCO_3$ extracts from soil. *Soil Science Society of America Journal*, 29: 677-678.

Wong. J.H.C., C. H. Lim and G. L. Nolen, Design of Remediation Systems, Lewis Publishers. Boca Raton, USA 1997.

****