

Remediation of Petroleum Oil Contaminated Soil by Using Organic Fertilizer

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Received: August 16, 2019; Published: September 26, 2019

DOI: 10.31080/ASAG.2019.03.0665

Abstract

Experiment was conducted at Agricultural farm to remediate crude oil contaminated soil with organic and inorganic fertilizers. For this thirty six pots were prepared and filled with 2.5 kg crude oil contaminated soils (0 - 20cm). The soils were contaminated with 150 ml crude oil and mixed with 150gm of poultry manure and 75gm of NPK fertilizer. Herbal plant like Indian Tulsa was planted in each pot. Results showed that this application reduced soil Total hydrocarbon about 87.0%. By using mixture of Inorganic and organic fertilizer mixtures are effective in the restoration of crude oil contaminated soils.

Keywords: Hydro Carbon Contamination; Petroleum Product and Crude Oil; NPK Fertilizer; Poultry Waste Manure; Remediation; Herbal Plant

Introduction

Pollution caused by petroleum and its side stream product is the most prevalent problem for nearby area of refinery. Since commercial exploration of petroleum has big contribution in growth of any country, petroleum industries has continuously grown in. However this industries has led to the pollution of land and water in different ways. Petroleum is a complex mixture of aliphatic, naphthenic and, aromatic hydrocarbons, and smaller proportions of heteroatom compounds, such as sulfur, nitrogen, and oxygen. Crude oil also having traces amount of organometallic complexes containing nickel and vanadium. These organometallic compounds are problematic during crude oil refining because it had adverse effect on various catalyst that used for refining of crude [1]. Invariably, oil spillage damages the soil, water and both plants and animals. Its pollution renders soils unproductiveness for years after spillage, also reducing the growth performance of plants by deteriorating fertility of soil [2]. Therefore, plant growth and establishment, and rejuvenation of polluted sites can serve as indicators for soil recovery [3]. Several methods are being adopted to remove oil wastes and derivatives from soil and water. These include physical methods), chemical method, and biological methods out of them several physical methods are spray, vapor extraction, solidification and stabilization. While example of chemical methods are photo oxidation, dissolution, detergent cleaning and on other hand example of biological methods are bioremediation. All these methods are applied for treatment of contaminated sites depends on the kind of contamination in each case. Phytoremediation is the one of the methodology in which plants are used to remove or render harmful pollutant from soil [4]. The application of some particular plant for remediation of soil that contaminated with petroleum hydrocarbon is one of the cost effective and eco-

friendly approach [5]. Schnoor [6] reported that phytoextraction is more effective with vigorously growing plants that are easily harvested and which accumulate large concentration of contaminants in harvestable form. Tithonia seedlings were able to absorb lead and cadmium in polluted soils, and contents in the root were more than contents in the shoot. The lead and cadmium contents in the shoot compared to the root were about 54% and 30% respectively [7]. Isitekhale., *et al.* [8] reported net remediation of 75.45% and 77.51% using vigorously growing sweet potato variety on crude oil contaminated soil; even with higher concentrations, growth was further sustained. Transformation of contaminants may occur outside the plant in the rhizosphere, inside the plant or sorbed to the leaf surface (photolysis) [9]. Sweet potato (*Ipomeabatata* L.). Ogboghodo., *et al.* [10] reported that adding chicken manure to soil that contaminated with crude oil resulting degradation of 75% of hydrocarbon in the soil within two weeks, and suggested that the use of chicken manure to stimulate crude oil degradation in the soil could be one of the most result oriented environmentally friendly ways of combating petroleum hydrocarbon pollution in the natural ecosystem. Eneje., *et al.* [11] reported that addition of organic materials such as poultry waste and plant waste singly or in combination to improve the chemical properties (pH, OC, total nitrogen, available P, Ca, K, and Mg) of the oil polluted soil not only that it will enhance the solubility and removal of these crude oil contaminants, improving oil biodegradation rates. Fertilizer (NPK) served as a good supplement for the growth of the petroleum utilizing bacteria in oil - polluted Journal of Environment and Earth Science www.iiste.org ISSN 2224 - 3216 (Paper) ISSN 2225 - 0948 (Online) Vol. 3, No.7, 2013 117 soils [12]. Leo and Iruka [13] reported that by using sufficient quantity of inorganic NPK fertilizer on the oil contaminated soil, it helps in the restoration of the carbon to

nutrient ratios to the optimum required to stimulate and sustain microbial activity, adjustment of the soil pH to 6.0 – 6.5 by the addition of lime and also the stimulation. Obire and Akinde [14] reported that nutrient supplementation of oil – polluted with poultry droppings as organic nutrient source in particular is beneficial for maize growth and it also enhances both biodegradation of oil and soil recovery. Poultry manure additions to soil giving very positive results in plant nutrients addition, enhancement of soil biological value and enhancement of crop growth and yield [15-17]. Therefore the aim behind this experiment is to employ poultry manure and/or N: P: K (16:16:16) fertilizer for the remediation of crude oil contaminated soil in order to enhance plant growth and yield.

Study area

The experiment was conducted at the coastal area of Gujarat state in India Gujarat state has a humid climate characterized by one rainy season between June and August and one dry season lasting from March to May. The temperature of Gujrat state is characterized of tropical climate with mean temperature of about 36.00C. Relative humidity is fairly high especially during the months of June to November.

Materials and Methods

The experiment was conducted by taking random sample of Soil (5 kg) in to perforated polyethylene bags (6 kg capacity). The experiment consisted of twelve polyethylene bags per replicate, giving a total of thirty six bags for the experiment. The soils were contaminated with 50% of crude oil. The soils were then allowed to equilibrate for 2 weeks; after a 14 days 2.5kg of poultry manure and 2.5kg of Gir breed cow shit was homogenously mixed and kept for next two week after giving enough equilibrium time Tithonia seedlings planted or sweet potato vine with two nodes was planted in each polyethylene bag. Poultry manure was collected from layers kept in chicken cages, it contain feces and urine that dropped down by chicken. The droppings were air dried for 6 months in order to ensure complete breakdown. The growth of Tithonia seedlings flower plant or sweet potato was monitored to 12th week. Some important parameter that determine quality of soil samples were tested in laboratory before and after contamination. Particle size distribution was determined by using the hydrometer method [18], soil pH was measured in a 1:1 ratio by taking soil and water by using glass electrode pH meter [19], organic carbon was done by wet dichromate acid oxidation method [20], total nitrogen was determined by the micro Kjeldahl method [21]. Available phosphorus was extracted with Bray II solution and determined by the molybdenum blue method on the Technicon auto - analyzer as modified by Olsen and Sommers [22], Potassium and sodium were determined with flame emission photometer while calcium and magnesium were determined with automatic adsorption spectrophotometer [23]. Total hydrocarbon content was analyzed by using a methylene chloride extraction; gas chromatography (GC) analyzing technique [24] the amount of crude oil lost from the soil was determined as the amount of crude oil added to the soil minus that in the soil at the time of analysis.

Results and Discussion

Soil Physical - Chemical Properties of the crude oil is measured, the physical - chemical properties of the soil that used for experiments also measured before crude oil contamination. The experimental soil having lower content of phosphorus, nitrogen and potassium but with marginal contents of magnesium and calcium. The surface sand of soil should be enables to percolate of the crude oil. Portray farm waste as manure and NPK fertilizer in combination added to crude oil contaminated soil.

Specific gravity (g/cm ³)	0.79
Viscosity at 38°C	0.25
Gas oil ratio	88.20
Carbon %	82.50
Hydrogen %	11.80
Sulphur %	1.32
Nitrogen %	0.36
Oxygen %	0.50
Metals (mg/kg)	
Iron	49.60
Nickel	2.80
Vanadium	0.40
Copper	3.0
Zinc	3.15
Lead	0.90
Cadmium	0.30
Cobalt	0.80

Table 1: Chemical properties of the crude oil used for the study.

After keeping this mixture for more than fifteen days in open climate with wetted form few piece of sweet potato or Tithonia was planted. Potato tuber weight increased significantly with the application of 3 t pm/ha + 300 and 400 kg NPK/ha. The very low yield obtained from the unfertilized soil is due to the harmful effects of crude oil to plants growth and yield. However, yield obtained from crude contaminated soil that treated with manure and fertilizer mixture was 6 t/ha [24]. Asuquo., *et al.* [26] observed that increases in organic carbon in crude oil contaminated soil create an initial scarcity of nitrogen. This nitrogen deficiency in an oil - soaked soil, effect on bacterial growth it retards the growth of bacteria also deficiency in certain nutrients like phosphorus which may be growth - rate limiting factor [27].

Total hydrocarbon content ranged from nil to 138.96 mg/kg after the soil was contaminated with 300 ml of crude oil. It was noted that the various treatments were effective in hydrocarbon removal. Net hydrocarbon remediation ranged from 111.96 to 262.86 mg/kg. The highest hydrocarbon removal was obtained by the application of 4 t pm/ha + 200 kg NPK/ha and 6 t pm/ha + 400 kg NPK/ha. This resulted in 87.62 and 86.97% net remediation respectively. All above observation shows that higher quantity of poultry manure in combination used with moderate to reach NPK fertilizer is very much effective for remediation of soils that contaminated

Crude oil pH (H ₂ O)	6.80
Total N (g/kg)	1.02
Total C (g/kg)	10.88
Cations (c mol/kg)	3.84
Total Mg (g/kg)	2.40
Na (g/kg)	0.33
K (g/kg)	0.08
Particle size (g/kg) Sand	941.00
Particle size (g/kg) Silt	16.00
Particle size (g/kg) clay	43.00

Table 2: Physico-chemical properties of the experimental soil.

with crude oil. Residual characteristics of poultry manure could further lead to more hydrocarbon removal. Residual characteristics of poultry manure have been documented [8,15]. Addition of organic materials such as poultry and green manure either alone or in combination use full to improve the chemical properties (pH, organic carbon, total nitrogen, available P, Ca, K, and Mg) of the oil contaminated soil. Thus, improve crude oil biodegradation rates [28-34].

Conclusion

Sweet potato or *Tithonia* a vigorously growing plant can reduce the level of crude oil in crude oil contaminated soil to tolerable limit as observed in this study. Remediation capacity of the growing potato or *Tithonia* could also be enhanced through manure and fertilizer mixtures. Thus, application of 4 t pm/ha + 200 kg NPK/ha and 6 t pm/ha + 400 kg NPK/ha to crude oil polluted soils will enhance crude oil remediation, soil nutrient addition and growth of plants.

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Volume 3 Issue 10 October 2019

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