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Effect of hydrocarbon industrial waste on soil physico-chemical and biological properties

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ABSTRACT

Nature of the soil is very important for plant growth and crop yield. The impact of hydrocarbon industrial wastes on soil physico-chemical and biological properties was assessed in the present study. Contamination of hydrocarbon industrial waste on to the soil caused changes in physico-chemical and biological properties except water holding capacity, sand, Potassium and Organic carbon. The remaining all other physico-chemical properties are lower than control. Higher bacterial and fungal populations were observed in the contaminated soil than control.

KEYWORDS

Hydrocarbon industry;
Industrial waste;
Physico-chemical;
Biological properties.

INTRODUCTION

The capacity of soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health. In this context, agriculture is particularly challenged to develop appropriate strategies for sustainable land use and integrated crop productivity. Soil is one of the most vital natural resources. It produces food for teeming millions and supplies raw materials for a large number industries on which the world economy is sustained. In fact, one other hand, progress of civilization and rapid industrialization brought with it danger of soil pollution. A perusal of the literature in the discharge of efluents on to the soil[1,2] strongly indicates that, they cause marked changes in physicochemical and biological properties. Hydrocarbon industry is an agro based industry, High viscose Carboxy methyl cellulose is main end product of this industry. While in the continuous running process of industry it releases waste, into surrounding terrestrial and aquatic systems. In fact, waste majorly contain considerable amounts of organic, inorganic pollutants Discharge of these effluents may alter the physicochemical and biological activities in terrestrial ecosystem including coastal marine and inland water bodies received more attention than inland terrestrial system[3,4].

The objective of this present study was to determine physicochemical and biological parameters of hydrocarbon industry contaminated soil.

MATERIALS AND METHODS

Collection of soil

Soil samples was collected from different location, where organic waste is being discharged by hydrocarbon factory located Nagari village, Chittor District of Andhra Pradesh, India. Soil samples with effluent discharges were used in all experiments conducted in the present study. These soil samples were air dried and mixed thoroughly to increase homogenic and shifted to < 2mm sieves for determination of soil texture and used for physico chemical and biological properties.

Physico-chemical properties of hydrocarbon industry waste

The hydrocarbon industry waste soil sample such as sand, silt clay contents was analyzed with use of different sizes of sieves by following method of Alexander[5]. Cent percent water holding capacity of soil sample was measured by finding amount of distilled water added to soil sample to get saturation point and then sixty percent water holding capacity of soil samples was calculated by the method of Johnson and Ulrich[6]. Soil P^H was measured at 1:1.25 soil to water in ratio in Elico digital pH meter with a calomel glass electrode assembly. Organic carbon content in soil samples was estimated by the walky and black method[7] and the organic matter was calculated by multiplying the values with 1.72. by the method of Jackson[8]. Electrical conductivity of soil sample with effluent discharges after addition of 100 mL distilled water to one gram of soil sample was measured by Conductivity bridge. Soluble phosphorous in soil sample was quantified by the method of[9].

TABLE 1 : Physico chemical properties of soil polluted with/ without contaminated soil

Properties	Contaminated soil	Control soil
Color	Light red color	Red color
Odor	Bad	Normal
Texture: (%)		
Sand	93.95	65.42
Silt	3.45	17.38
Clay	2.6	17.20
pH	8.5	8.6
Electrical conductivity(μmhos/cm)	0.35	0.93
Water holding capacity(ml/g of soil)	0.6	0.4
Organic carbon (%)	high	low
Phosphorus(kg/h)	56	50
Potassium(kg/h)	78	115

Microbial properties of soil contaminated with hydrocarbon industry waste

Microbial cultures such as bacteria and fungi both isolated and enumerated from two soil samples by taking 1g of soil sample separately and serially diluted up to 10^{-10}. Diluted suspensions of 0.1ml samples were plated and spread with sterile spreader on nutrient agar (pH 7.4) and potato dextrose agar (pH 6.5) medium for bacteria and fungi, respectively. Nutrient agar plates were incubated at 37°C (centigrade) for 24 h, where as potato dextrose agar medium plates were at 28°C for 7 days. After the incubation period, colonies appeared on the agar media are counted by colony counter.

RESULTS AND DISCUSSION

Physicochemical characters

Soil fertility mediated by microorganism is dependent on maintenance of physico-chemical characteristics in soil. Therefore contaminated soil sample was analyzed. These properties are represented in the TABLE 1. Soil sample contaminated with hydrocarbon waste underwent changes in all measured parameters of physical and chemical properties. The industrial waste made the soil unpleasant and imports light red color to soil. Electrical conductivity of contaminated soil was 0.35μmhos/cm and water holding capacity was high than control soil. Increased water holding capacity and decreased electrical conductivity in the soil may be due to accumulation of organic wastes in the form of cellulosic fibre (cotton fibre) to the soil. Soil texture in terms of percentage of sand, silt and clay were 93.95, 3.45 and 2.6 in the test; 65.42, 17.38 and 17.20 in the control soils, respectively. The above results indicated that test samples had relatively higher sand, lower silt and clay contents than control samples. The pH of the test sample was decreased to 8.5 from8.6 in contaminated soil. Higher organic carbon, phosphorous and lower Potassium content were observed in contaminated soil. One of the possible reasons for improving the soil properties could be due to organic waste that may contribute to maintain or increase the organic matter and nutrient content in the soil[10] Wealth

TABLE 2 : Microbial population in contaminated soil

Parameter	Contaminated soil	Control soil
Bacteria	110×10^3	60×10^3
Fungi	3×10^3	2×10^3

of information is available on effect of industrial efluents and their influence on soils. Invariably, with most studies showing that most effluent application is beneficial such a role may be limited to situations where the effluent is to be applied at an amount, or has a composition that has not been previously tested[11]. In this study, hydrocarbon industry waste had relatively higher clay and silt contents than the control soil. Other studies have found the same, like long term application of sewage effluents and cotton ginning mill effluents[2]. However, increased water holding capacity and electrical conductivity in the test soil may be due to accumulation of organic wastes and salts in the hydrocarbon industry effluents. Likewise, similar results observed in soils discharged with effluents from cotton ginning mills[2], Paper mills[12]. High electrical conductivity was also observed in soils treated with distillery effluents[13] and sodium based black liquor from fiber pulping for paper making[14]. In contrast, soils polluted with cement dust from cement industries had low water holding capacity and high electrical conductivity[15]. The slight drop in the pH of the test soil is explained in terms of release of effluents with acidic in nature, containing agro based chemicals from sugar industry. Same reports was noticed in the discharges of sugar cane residues from sugar industry[16], application of sewage effluents[17] to soils decrease the pH. The higher organic matter of the test soil may be due to the discharge of effluents in an organic nature. Similarly, disposal of municipal organic compost[18] long term municipal waste[19], and the effluents from cotton ginning mills[2] into soils, significantly increased the soil organic matter and total nitrogen content. Higher microbial population in the test soil possibly due to the presence of high organic matter in acidic effluents. Similarly[2,20] reported that microbial populations were profusely increased in soils polluted with alcohol and cotton ginning mills effluents respectively.

Biological properties

The microorganisms play a vital role in nutrient cycling and soil fertility. Micro flora of both soil samples was enumerated and listed in TABLE 2.

Bacterial and fungal populations were observed and compared with control soil. Higher bacterial and fungal populations were observed in the contaminated soil. Higher bacterial and fungal population in the contaminated soil may be due to higher stabilized pH in the soil. In contrast irrigation with lactose dairy factory effluent enhanced soil biological activity and nutrient cycling[2,21,22], reported that discharge of effluents from cotton ginning industry and sugar industry[23], improved soil microbial populations. For instance bacterial and fungal population in hydrocarbon industry waste soil was 110×10^3 CFU/g, 3×10^3 CFU/g of soil respectively. Two fold higher bacterial and fungal populations were observed in the test soil over the control.

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