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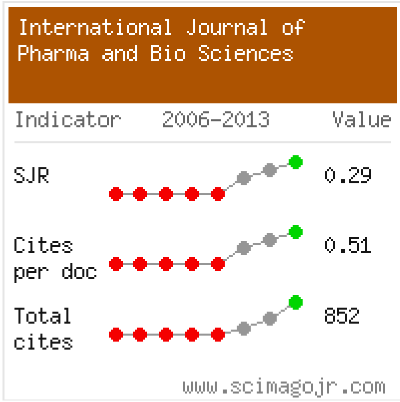

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EFFECT OF POULTRY DROPPINGS ON DIESEL CONTAMINATED SOIL AND EVALUATING ITS PHYSICOCHEMICAL PROPERTIES

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ABSTRACT

This work was designed to determine the effect of poultry droppings on diesel contaminated soil and evaluate its physiochemical properties. In this study, different ratios of diesel contaminated soil and poultry droppings have been used as raw materials. The mixture of diesel contaminated soil and poultry droppings were allowed to composting process for 40 days. The physicochemical parameters like pH, EC, organic carbon, organic matter, total nitrogen, total phosphorous, total potassium, enzymes level (alkaline phosphatase(ALP), acid phosphatase (ACP), dehydrogenase and urease) and microbial population were analysed at 0, 10, 20, 30 and 40 days intervals of poultry droppings treated diesel contaminated soil. The changes created by poultry droppings on diesel contamination resulted in change of intensity of some physicochemical properties such as pH, EC, macro and micro nutrients, enzymes level, microbial population and soil fertility indices. The results indicated that macro and micro nutrients level can be increased via composting method. This bio remediated soil is suitable for crop cultivation.

KEYWORDS: Diesel contaminated soil, Poultry droppings, Physicochemical properties, Microbial population.

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INTRODUCTION

Diesel is a complex mixture of alkanes and aromatic compounds obtained from the gas-oil fraction during petroleum separation[1]. Soil is contaminated by diesel via leaking from storage tanks and pipelines or released in accidental spills[2]. With the continuous consumption of diesel fuel by many vehicles and generators, greater amounts of diesel oil are being transported over long distances. So, diesel oil can enter into the environment through leakage. The petroleum products contain volatile and non-volatile compounds, in which some gaseous compounds can easily volatilize and there is oil pollution leaving the non-volatile components as residues in and on the soil[3]. Minai-Tehrani and Herfatmanesh[4] have demonstrated that the oil spillage affects the physical and chemical nature of soils. Nwachukwu and Ugorji[5] reported that oil pollution cause serious damage to vegetation, soil micro-organisms and soil fertility. One of the greatest methods to restore contaminated soil is to make use of microorganisms that are able to degrade those toxic compounds in a bioremediation process[6]. The microbial biomass are generally considered to be important in bioremediation. Diesel oil bioremediation in soil can be improved by stimulation of the native microorganisms, by supplying nutrients and oxygen into the soil (bio stimulation)[7] or through inoculation of an enriched microbial consortium into the soil (bio augmentation)[8,9]. The aim of the present study is to determine the effect of poultry droppings on diesel oil contaminated soil and evaluate its physiochemical properties.

MATERIALS AND METHODS

COLLECTION OF SOIL AND POULTRY DROPPINGS

The poultry droppings (feathers free) were obtained from a poultry farm located at Sulur, Coimbatore, Tamil Nadu, India. The red soil for the study was taken from the agricultural lands near Pollachi, Coimbatore, Tamil Nadu, India.

EXPERIMENTAL SETUP

This investigation was carried out with three replications at Karpagam University campus, Coimbatore (11˚16'N; 76˚58'E), Tamil Nadu. The agricultural soil was contaminated artificially by diesel with poultry droppings (w/w) in different ratios and these have been used as raw materials. Diesel contaminated soil and poultry droppings were mixed and put into separate tank (1 m depths). Eight different ratios of diesel contaminated soil and poultry droppings (T_1-T_8). Diesel contaminated soil treatment (without poultry dropping) was also taken for this study as control. The treatment details are presented in Table 1. Treatments were allowed to compost for 40 days at normal room temperature. A thorough turning was made every 15 days. Moisture content (65-75%) was maintained throughout this study. On zero (Initial) day, 10th, 20th, 30th and 40th day samples were collected for further analysis. The physicochemical properties of normal soil, diesel contaminated soil and poultry droppings are shown in Table 2.

Table 1
The composition details of raw waste in different treatments

Treatment	Details
T_1	10 kg of normal soil
T_2	10 kg of diesel contaminated soil
T_3	10 kg of poultry droppings
T_4	9.5 kg of diesel contaminated soil+0.5 kg of poultry droppings
T_5	9 kg of diesel contaminated soil+1 kg of poultry droppings
T_6	8.5 kg of diesel contaminated soil+1.5 kg of poultry droppings
T_7	8 kg of diesel contaminated soil+2 kg of poultry droppings
T_8	7.5 kg of diesel contaminated soil+2.5 kg of poultry droppings

Table 2
Physicochemical properties of normal soil, contaminated soil and poultry droppings

S.No	Properties	Normal soil	Diesel contaminated soil	Poultry droppings
1	pH	6.8 ± 0.02	5.7 ± 0.01	6.9 ± 0.01
2	Electrical conductivity (dSm^{-1})	1.40 ± 0.45	2.56 ± 0.12	1.02 ± 0.15
3	Organic carbon (%)	38.1 ± 2.15	45.23 ± 1.16	35.26 ± 1.02
4	Nitrogen (%)	1.54 ± 0.05	2.78 ± 0.05	0.65 ± 0.01
5	Phosphorous (%)	0.77 ± 0.01	0.65 ± 0.02	0.32 ± 0.01
6	Potassium (%)	1.58 ± 0.01	1.34 ± 0.01	0.43 ± 0.01
7	C:N ratio	24.70 ± 2.13	69.55 ± 1.78	54.60 ± 1.59
8	Zinc (mg/kg)	92.78 ± 0.02	32.96 ± 0.02	10.20 ± 0.01
9	Copper (mg/kg)	2.56 ± 0.01	10.50 ± 0.06	2.10 ± 0.05
10	Manganese (mg/kg)	78.90 ± 2.56	62.00 ± 2.15	1.42 ± 0.01
11	Iron (mg/kg)	3547.9 ± 1.65	5028.02 ± 2.28	160.01 ± 2.25
12	Sodium (mg/kg)	28.75 ± 2.09	28.10 ± 0.84	30.23 ± 2.59
13	Calcium (mg/kg)	2.4 ± 0.18	10.20 ± 0.19	1.20 ± 0.10
14	Lead (mg/kg)	Nil	2.06 ± 0.08	1.00 ± 0.10
15	Cadmium (mg/kg)	Nil	0.10± 0.01	0.80 ± 0.10
16	Urease (µg g^{-1})	0.50 ± 0.01	0.15 ± 0.02	0.10 ± 0.02
17	Alkaline phosphatase (µg g^{-1})	0.46 ± 0.01	0.11 ± 0.01	0.12 ± 0.01
18	Acid phosphatase (µg g^{-1})	0.38 ± 0.005	0.10 ± 0.01	0.15 ± 0.01
19	Bacteria (10^{-6} CFU)	96	42	112
20	Fungi (10^{-5} CFU)	32	18	58

ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES AND MICROBIAL POPULATION

The pH and electrical conductivity (EC) of poultry droppings and treated diesel contaminated soil were measured using pH meter and Delux conductivity meter respectively[10].Total nitrogen content was determined by kjeldahal digestion[11]. Total potassium level was estimated using flame photometer[10]. Total phosphorus content was analysed by colorimetric method[12]. Micronutrients [Zinc (Zn), Copper (Cu), Iron (Fe) and Manganese (Mn)] were determined by atomic absorption spectrophotometry[13]. Different enzymes such as phosphatase[14] and urease[15] levels were also analysed in poultry droppings treated diesel contaminated soil. Microbes (bacteria and fungi) from poultry droppings treated diesel contaminated soil were counted by serial dilution plate technique using nutrient agar and potato dextrose agar respectively[16].

RESULTS AND DISCUSSION

The pH of the diesel contaminated soil was changed by adding poultry droppings. The pH of all treatments ranged between 5.7 and 7.02 which are significantly reduced adding the poultry droppings. The changes in pH were observed in different treatments at various time intervals and are shown in (Figure 1). Hogg *et al*.[17]reported that pH range 6.0 – 8.5 for soils was suitable for plant growth. The EC values of all treatments were in the range of 1.04 – 2.35 dSm^{-1} on 10th -40th day, which were significantly increased from the initial mixtures (Figure 2).The EC value denote that the level of soluble salt content in the soil and for the level of macro- and micronutrients in the soil. The EC value of diesel contaminated soil alone (T_2) had no change at different time intervals. The highest EC value was observed in control soil (i.e. diesel contaminated soil). Highest poultry droppings mixed soil showed maximum level of EC value. Hawrot and Nowak[18] have reported that gasoline contaminations affect the physicochemical properties of soil. Ujowundu *et al*.[19] investigated the biochemical and physical properties of diesel-contaminated soil in southeastern Nigeria and reported that soil properties were affected by diesel. Organic carbon content was examined in diesel contaminated soil and poultry droppings mixed diesel contaminated soil (Figure 3). Organic carbon level was decreased from initial day to 40th day. In diesel contaminated soil no variations in organic carbon level after 40th day. On 10th- 40th day, poultry droppings mixed soil treatments have shown reduction of organic carbon. The lowest amount of organic carbon (36.3%) was present in T_8 and highest in T_4 (43.7%) on 40th day. The organic carbon content was reduced in final mixture, when compared to the initial mixtures. Maximum amount of organic carbon and organic matter in the contaminated soil samples may be due to gasoline fuel, which is composed of polycyclic aromatic hydrocarbons (Atlas, 1981)[20]. The nitrogen, phosphorus and potassium (macronutrients) level was significantly increased in poultry droppings mixed soil on 40th day. The final day mixture had greater levels of macronutrients than initial mixtures (Figure 4-6). The changes in treatments are statistically significant for the macronutrients (N, P and K) and were found to be increased in 40th day mixtures. In diesel contaminated soil (T_3 treatment) no changes were observed. Nitrogen level has been increased due to microbes which are responsible for conversion of ammonium nitrogen into nitrate. The conversion of ammonium nitrogen into nitrate[21] may be responsible for addition of nitrogen level in the compost. Osuji and Nwoye[22] proposed that it is unlikely that the oil release is directly responsible for the loss of macronutrients from soil. High level of extractable nitrogen in soil could be due to the nitrogen content of refined gasoline fuel[23].

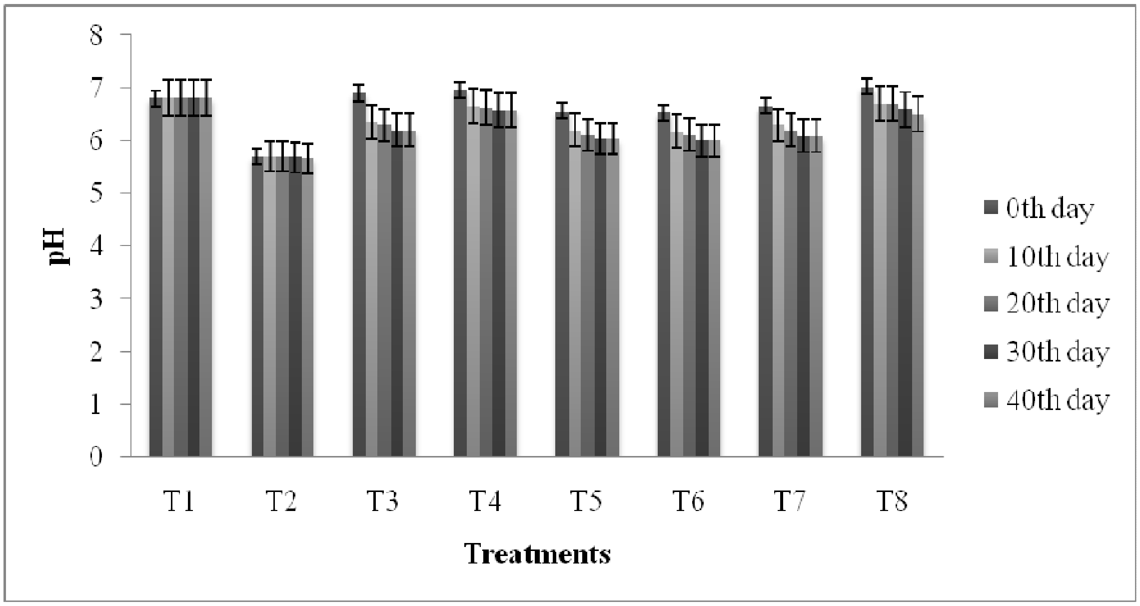

Figure 1
Effect of pH on diesel contaminated and poultry droppings treated diesel contaminated soil

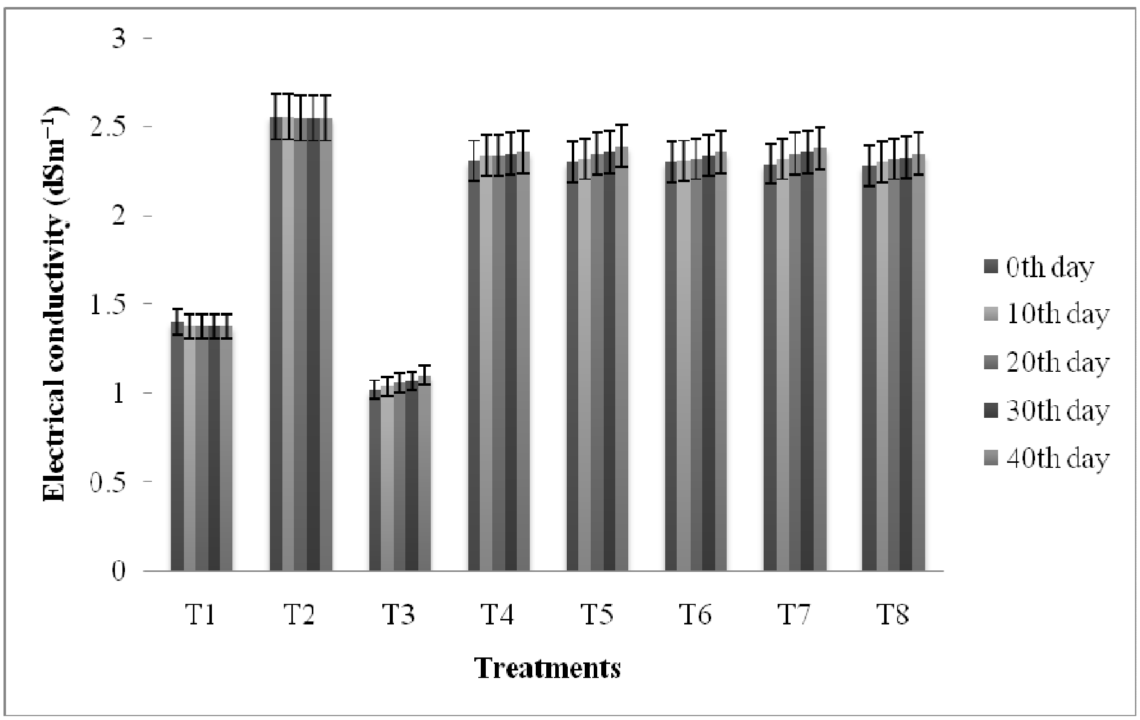

Figure 2
Effect of EC (dSm^{-1}) on diesel contaminated and poultry Droppings treated diesel contaminated soil

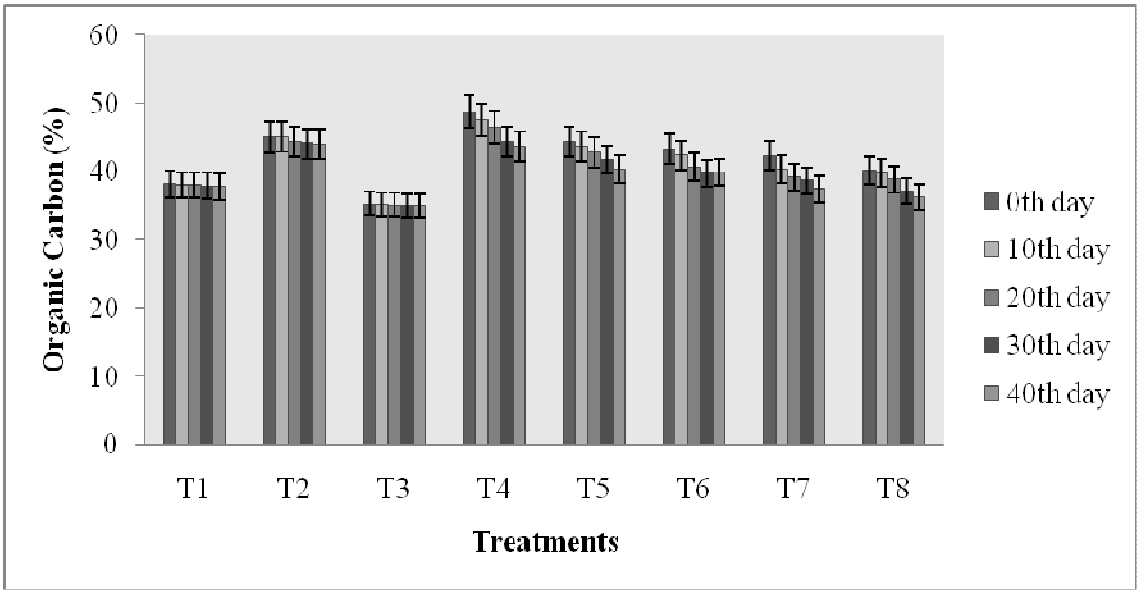

Figure 3
Analysis of organic carbon level (%) on diesel contaminated and poultry Droppings treated diesel contaminated soil

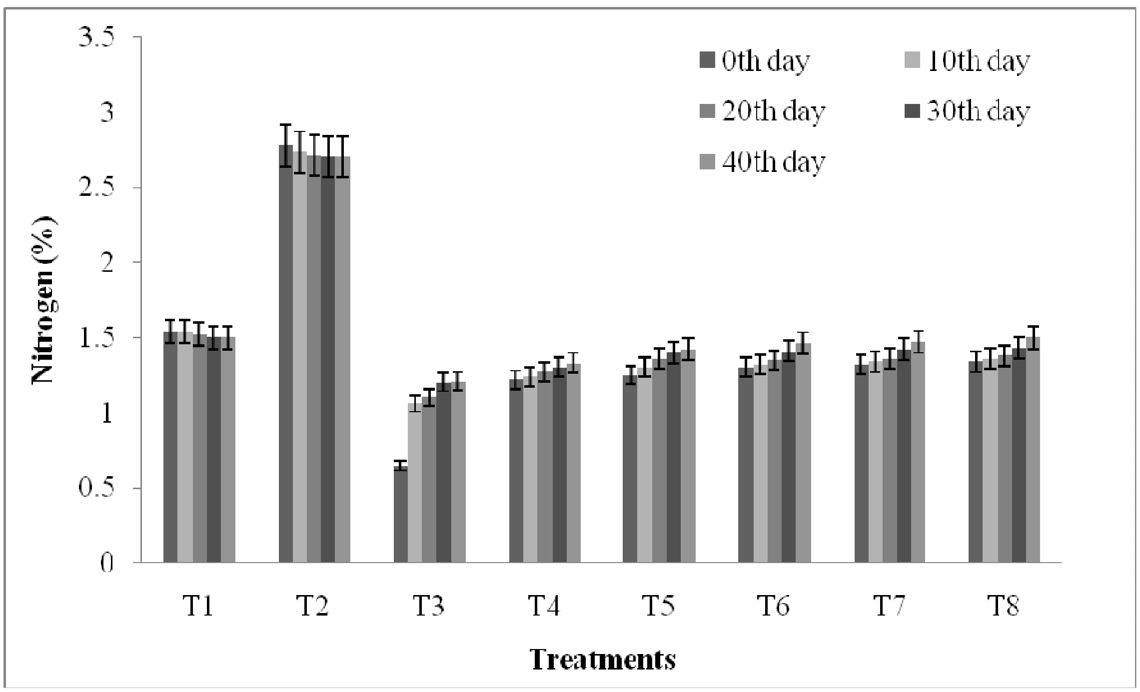

Figure 4
Analysis of Nitrogen level (%) on diesel contaminated and poultry Droppings treated diesel contaminated soil

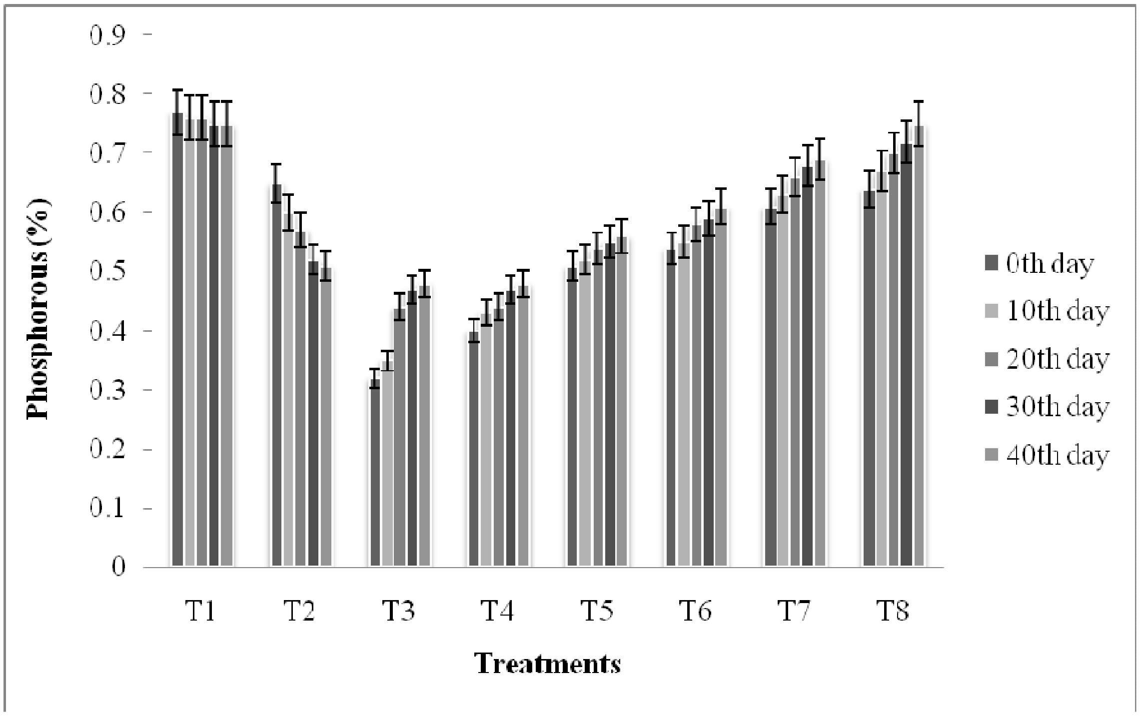

Figure 5
Analysis of Phosphorous level (%) on diesel contaminated and Poultry droppings treated diesel contaminated soil

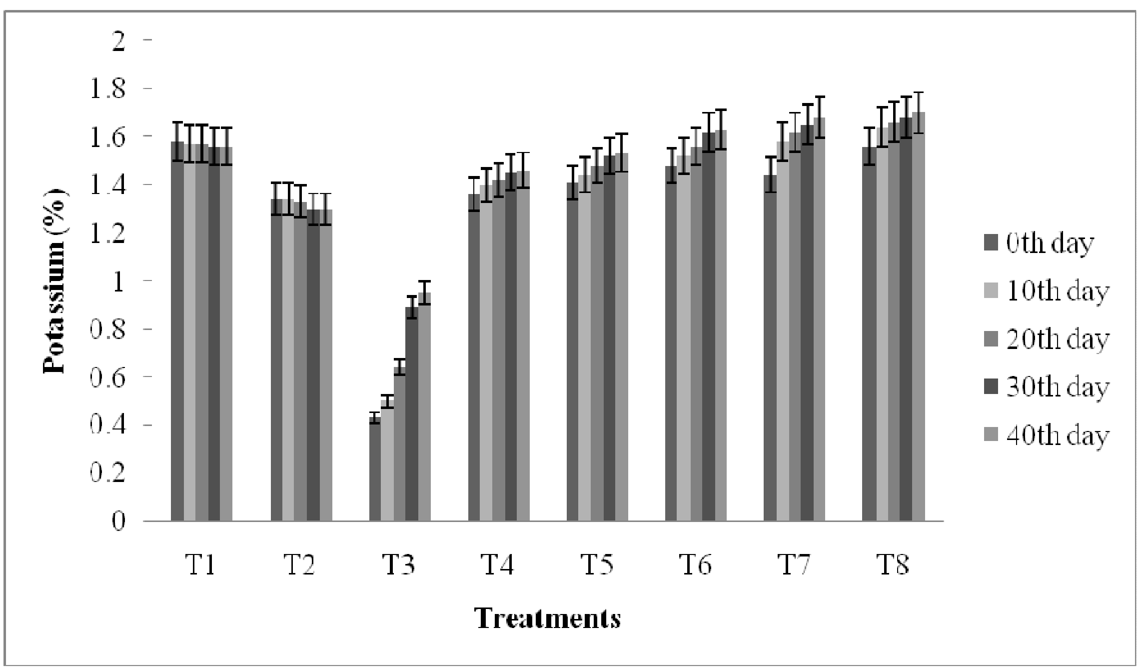

Figure 6
Analysis of Potassium level (%) on diesel contaminated and poultry droppings treated diesel contaminated soil

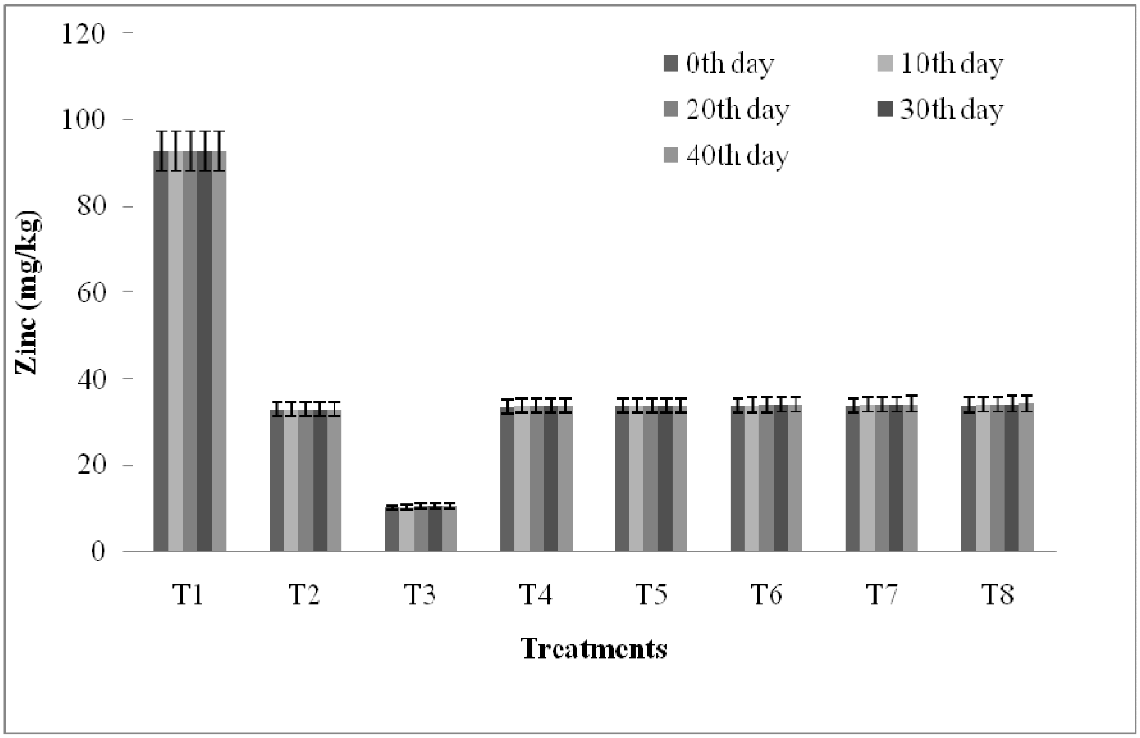

Figure 7
Analysis of Zinc level (mg/kg) on diesel contaminated and poultry droppings treated diesel contaminated soil

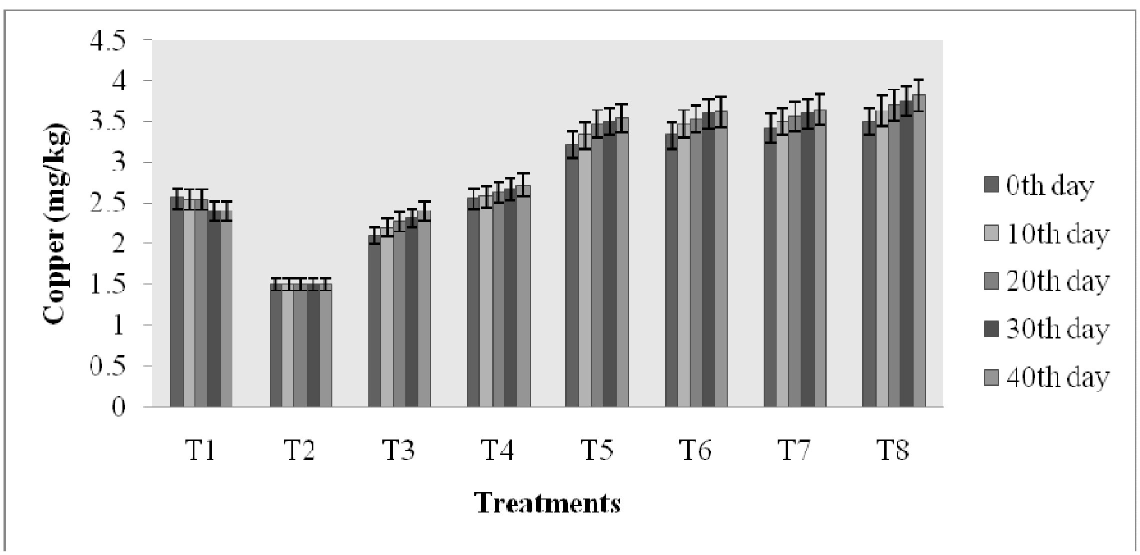

Figure 8
Analysis of Copper level (mg/kg) on diesel contaminated and Poultry droppings treated diesel contaminated soil

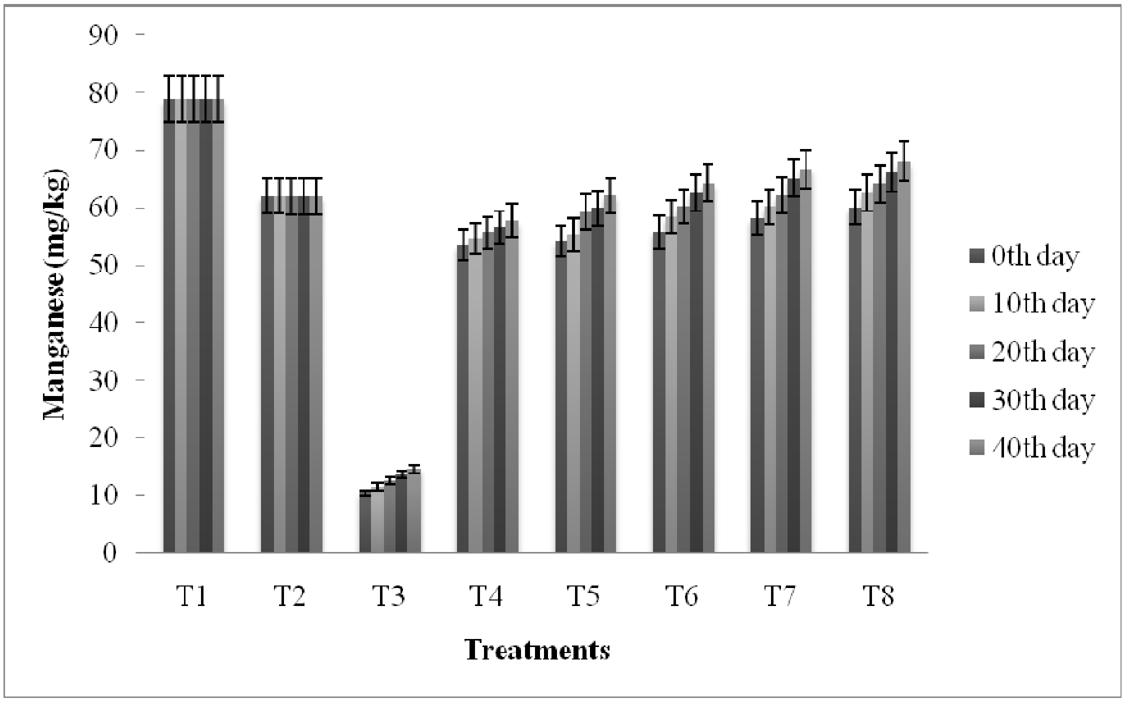

Figure 9
Analysis of Manganese level (mg/kg) on diesel contaminated and poultry droppings treated diesel contaminated soil

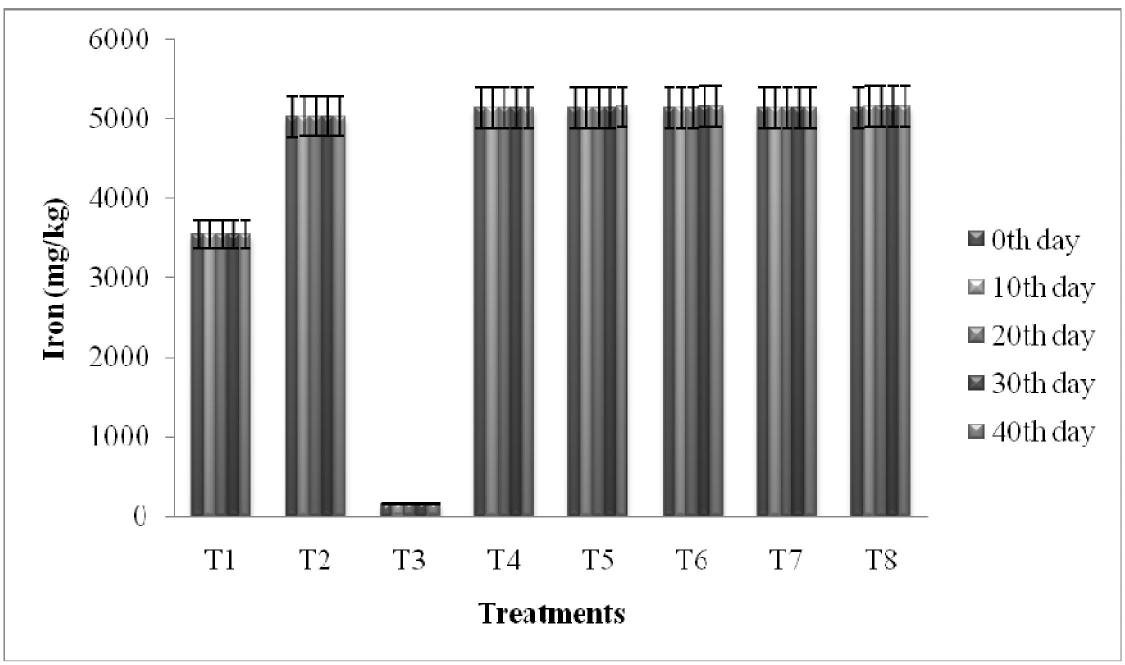

Figure 10
Analysis of Iron level (mg/kg) on diesel contaminated and Poultry dropping treated diesel contaminated soil

The maximum level (0.75%) of phosphorus was found in T_8 and low level (0.48%) in T_4 in 40^{th} day vermicompost. T_2 treatment had no changes in phosphorus level. On 0^{th} day, initial day mixture's phosphorous level ranged from 0.40 to 0.64% and the treatments differences were significant. The maximum level (0.75%) of phosphorus was observed in T_8, while low level (0.48%) in T_4 in 40^{th} day treatments (poultry dropping treated). Diesel contaminated soil treated with poultry droppings had higher potassium concentrations on final day (40th day) than initial levels. Highest level of potassium was obtained on 40th day in T_8. The initial day mixture's potassium level ranged from 1.36 to 1.56%. Micronutrients such as zinc, copper, manganese and iron were significantly increased in all treatments (Figure 7-10). On 40th day, the poultry dropping treated diesel contaminated soil had low amount of zinc, which ranged from 33.80 to 34.20 mg/kg. The initial mixtures had minimum amount of zinc, when compared to final mixtures of poultry and diesel contaminated soil. The copper level was higher (3.82 – 2.72 mg/kg) in all treatments on 40th day and lower (3.50 – 2.55 mg/kg) in initial mixtures on 0th day. The minimum level of iron was found in T_4 (5133.55 mg/kg) and maximum level (5140.12 mg/kg) in T_9 on 0th day. At 40th day, high amount of iron content was observed in T_8 (5148.07 mg/kg) and low amount (5137.12 mg/kg) in T_4. Highest level of manganese was noted in highest concentration of poultry mixed diesel contaminated soil treatment, which ranged from 68.07 mg/kg to 57.72 mg/kg on 40th day.In 0th day, the initial poultry droppings and diesel contaminated soil mixtures contained low amount of manganese, ranging from 60.12 to 53.55 mg/kg. The acid and alkaline phosphatase level was high in 40th day mixture in T_8. The lowest activity was observed in T_4 in 40th day mixture of diesel contaminated soil and poultry droppings. Enzyme level was greatly increased at 40th day compared to 0th day. The enzymes levels are shown in Figure (11-13). Urease enzyme level was highly increased in $T_4 < T_5 < T_6 < T_7 < T_8$ on different day intervals. The bacterial and fungi count was high in T_8 and T_7. Bacterial count observed was in the range of 155-172 X 10^5 CFU in T_4 –T_8. Fungi colony ranged from 74 - 126 X 10^5 CFU and was obtained in 40th day mixtures. Hence, this study clearly reveals the microbial population as one of the factor for increasing the enzyme level of all the treatments. Figure 14 and 15 shows the bacterial and fungi count at different treatments.The fungal growth rates observed in colony forming units were 1.1 X 10^6 CFU/g in the diesel contaminated and 5.4 X 10^6 CFU/g in the uncontaminated soil[24].

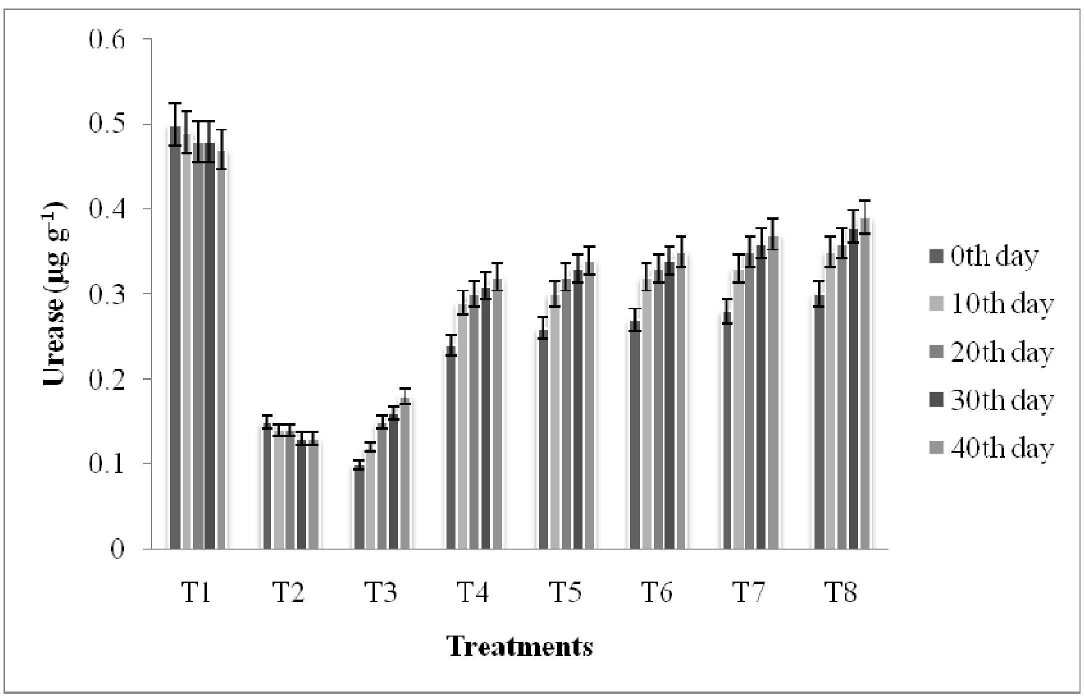

Figure 11
Analysis of Urease level (µg g^{-1}) on diesel contaminated and Poultry droppings treated diesel contaminated soil

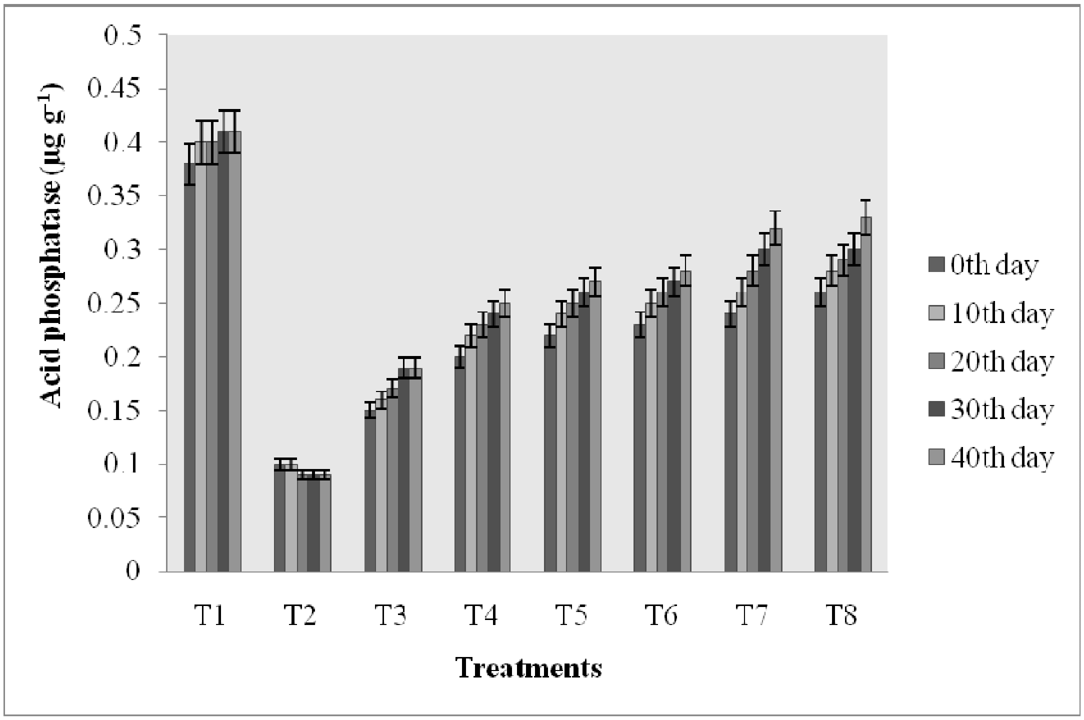

Figure 12
Analysis of Acid phosphatase level (μg g^{-1}) on diesel contaminated and poultry droppings treated diesel contaminated soil

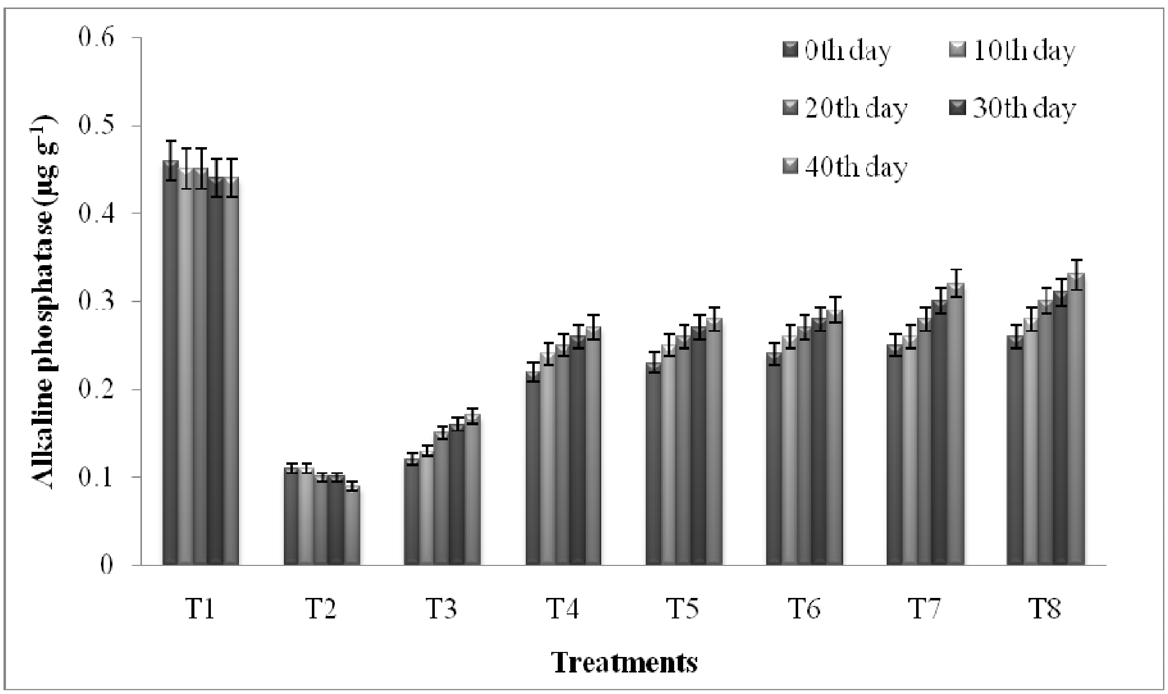

Figure 13
Analysis of Alkaline phosphatase level (μg g^{-1}) on diesel contaminated and poultry droppings treated diesel contaminated soil

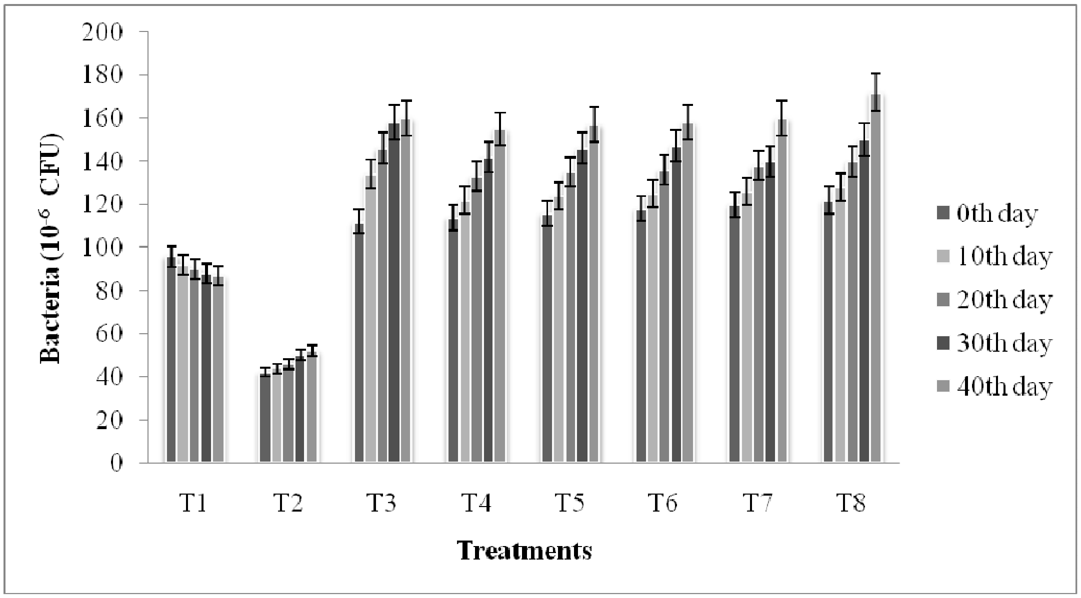

Figure 14
Analysis of Bacterial population (10^{-6} CFU) on diesel contaminated and Poultry droppings treated diesel contaminated soil

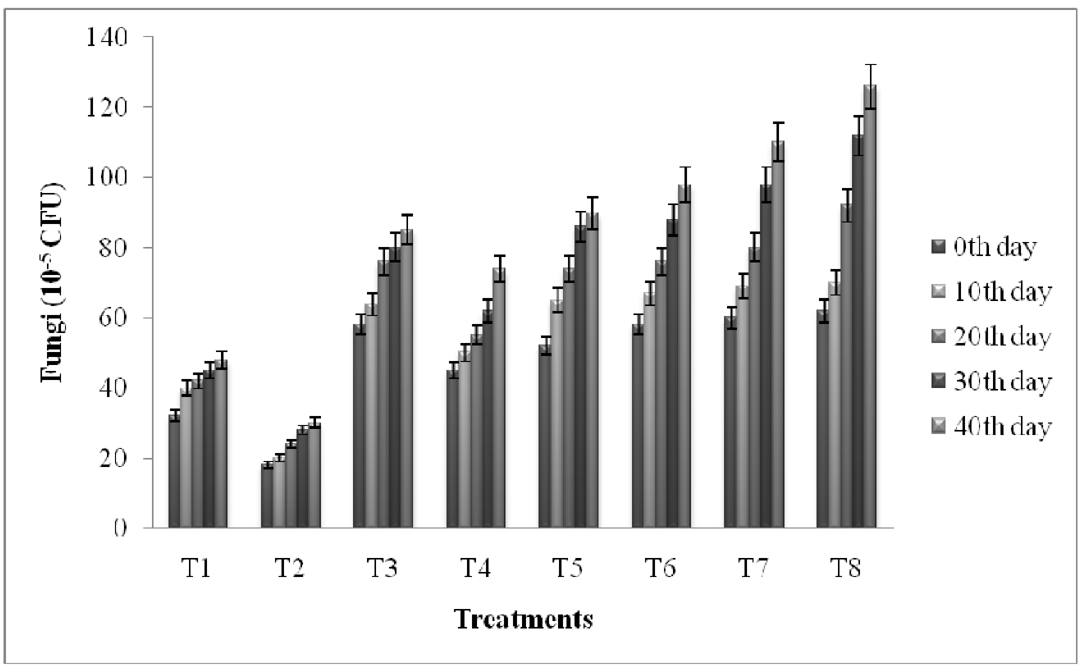

Figure 15
Analysis of Fungal population (10^{-5} CFU) on diesel contaminated and poultry droppings treated diesel contaminated soil.

CONCLUSION

The present investigation revealed that diesel contaminated soil had changes in the physicochemical properties and microbial population. The poultry droppings mixed diesel contaminated soil treatments were good in physicochemical properties as well as in microbial population, which are suitable for plant growth and continuously supply the nutrients to plants, which may lead to increase in crop yield.

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