Effect of paraffin on the urease activity of soil

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ABSTRACT: Accurate understanding of the effects of contaminants in soil is essential for management in bioremediation. The influence of soil pollution with petroleum hydrocarbons depended on the type of soil, petroleum hydrocarbons concentration in soil and mineral fertilization. Activity of the enzymes can give information on the kind and duration of the effects of contaminant on the metabolic activity of soil. So the aim of this work was to ascertain the effects of paraffin on soil urease activity. For this, urease activity was studied in soil contaminated at a loading rate of 5%, 10% and 15% with paraffin on 2, 30, 60, 90 and 120 days after contamination. The results showed the urease activity increased after the addition of Paraffin 5% (0.6%). But with increases level Paraffin, the urease activity reduced. Thus urease activity in soil can be used as bioindicator of anthropogenic stress caused by organic pollution.

Keywords: Soil pollution, paraffin, Enzyme activity, Bioindicator

INTRODUCTION

Petroleum hydrocarbons are one of the most frequently encountered pollutants in soil habitats due to the increased use of petroleum products and the seemingly increasing probability of accidents. Soil contaminated with Petroleum has a serious hazard to human health, causes organic pollution of ground water which limits its use, causes economic loss, environmental problems, and decreases the agricultural productivity of the soil. Contaminants interact with soil microorganisms to the soil ecosystem. After the normal metabolic activities and functions of soil microorganisms are hindered by pollution, microbial nutrient processes and enzyme activities as well as soil fertility and production will be reduced. Damage derived from petroleum hydrocarbon contamination will depend on the type and concentration of the contaminant (Olcay, 2011). It has generally been accepted that the susceptibility of hydrocarbons to microbial attack decreases in the following order: n-alkanes > branched alkanes > low-molecular weight aromatics > cyclic alkanes (Obbard et al., 2004). Pollutants introduced into soil exert an influence on the microbiota, which manifests as changes in biological parameters such as enzyme activities, and microbial counts. There is mounting evidence that soil biological parameters may have potential as early and sensitive indicators for measuring the degree of soil degradation in both natural and agro-ecosystems. This is because they particularly suit to measure the impact of pollution on the quality of soil (Dick and Tabatabai, 1992; Gianfreda et al., 2005; Xinhua et al., 2010). Microorganisms, being in intimate contact with the soil environment, are considered to be the best indicators of soil pollution. In general, they are very sensitive to low concentrations of contaminants and rapidly respond to soil perturbation. A change of their activity and diversity may result, and in turn it will reflect in a reduced soil quality (Schloter et al., 2003; Andreoni et al., 2004). Because: (i) they are a measure of the soil microbial activity and therefore they are strictly related to the nutrient cycles and transformations, (ii) they may fast react to the changes caused by both natural and anthropogenic factors and (iii) they are easy to measure. Contaminants may well provide as organic carbon sources, and an enrichment of oil degrading microbial populations (Margesin et al., 2000). The measurement of microbiological parameters, such as enzyme activity, provides information on the presence and activity of viable microorganisms as well as on the intensity, kind and duration of the effects of hydrocarbon pollution on soil metabolic activity. Also measured enzyme activity may provide additional information for bioremediation treatability testing. Therefore, the aim of this paper is to determine the impact of paraffin on urease activity in soil. For this, soil was treated with varying doses of the paraffin. Incubation study was carried out for 120 days under controlled conditions and the urease activity were determined during the incubation period.
MATERIALS AND METHODS

Soil samples were collected from the top 20 cm of an agricultural field located in Hashtgerd, Iran. After removing all stones, visible roots and fauna in the soil samples, the soil samples were air-dried at room temperature and sieved (< 2 mm) soil samples; Particle size distribution analysis was carried out by the pipette method; Electrical conductivity (EC) and pH of soil were measured in sample extracts obtained by shaking the material with distilled water at 1:5 (w/v) sample: water ratio using a conductivity meter (Jenway-4510) and pH meter (PHM-2000), respectively; organic matter was determined by dichromate oxidation; total N with Kjeldahl method; labile phosphate with bicarbonate extraction; available potassium was determined with Ammonium acetate. In an effort to evaluate the effect of Paraffin on urease activity, soils were homogenized, placed in glass pots (500 g per pot) and contaminated with paraffin at three different loading rates (5, 10 and 15% w/w). In order to get a good and homogeneous distribution of contaminants in the soil, soils were polluted by adding a suspension of the corresponding amount of each hydrocarbon in the amount of water necessary to bring the soil to 70% of its water holding capacity (WHC). Soils were incubated at room temperature for 120 days and soil moisture was maintained at 50–70% of their WHC according to weight, adding distilled water when necessary. Soil without the addition of hydrocarbon was utilized as a control. A randomized complete plot design with three replicates per treatment was used. Soil was homogenized prior to sampling. Soil urease activity measurements were conducted on 2, 30, 60, 90 and 120 days. Soil urease activity was assayed by the method of Tabatabai (1972). Five grams dry soil was treated with 0.2 ml toluene, 9 ml THAM buffer solution (pH 9) and 1 ml 0.2M urea solution at 37°C for 2 h. Following incubation, enzyme activity was stopped by the addition of 35 ml KCl (2.5 M)–Ag2SO4 (100 ppm) solution and NH+4–N in the soil suspension was determined by vapor distillation.

RESULTS AND DISCUSSION

The data presented in Table 1 depicted that the soil used in the incubation study was loam in texture (sand: 37.08%, silt: 40% and clay: 22.92%). The soil was slightly alkaline (pH 7.8) in reaction and the electrical conductivity was 225 µS/cm. The field capacity of the experimental soil was 31%. The soil had 910 mg/kg total N, 17.5 mg/kg P and 345 mg/kg K. The results indicated that soil organic carbon content was 1.48%.

Table 1. General properties of soil samples used in the incubation study.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Soil</th>
</tr>
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<tbody>
<tr>
<td>Sand</td>
<td>37.1</td>
</tr>
<tr>
<td>Silt</td>
<td>40</td>
</tr>
<tr>
<td>Clay</td>
<td>23.9</td>
</tr>
<tr>
<td>Texture</td>
<td>Loam</td>
</tr>
<tr>
<td>pH (1:5, solid: water)</td>
<td>7.8</td>
</tr>
<tr>
<td>EC (1:5, solid: water) µS/cm</td>
<td>225</td>
</tr>
<tr>
<td>Field capacity (%)</td>
<td>31</td>
</tr>
<tr>
<td>Total N (mg/kg)</td>
<td>910</td>
</tr>
<tr>
<td>P-Olsen (mg/kg)</td>
<td>17.5</td>
</tr>
<tr>
<td>Available K (mg/kg)</td>
<td>345</td>
</tr>
<tr>
<td>Organic C (%)</td>
<td>1.48</td>
</tr>
</tbody>
</table>

a Dry weight basis

Urease activity in soil originated from soil microbes containing urease. Some species of bacteria, fungi and yeast contained urease. Almost 17 to 77% soil bacteria and 78 to 98% soil fungi have ability to hydrolyzing urea. Most of the nitrozomonase and nitrosospira were capable of hydrolyzing urea. Some factors such as temperature, pH, moisture content, oxygen and organic matter affected on production of urease by microorganisms. Fig. 1 shows the variation in urease activity of contaminated soil. The stimulation of urease activity observed immediately after the addition of Paraffin 5% contaminants (0.6%). This increase may be due to the presence of compounds in the added hydrocarbons which can initially be used as substrates by this enzyme. But with increases level Paraffin, the urease activity reduced. The inhibitory effect persisted 120 days after pollution. The observed inhibition in high concentration is probably due to the suppression of the microbial populations involved in the N, P, or C cycles, which would affect the degradation of organic compounds.
Figure 1. Variation in urease activity of soil treated with varying levels of paraffin at different times

CONCLUSIONS

This investigation has revealed that the contamination of soil with paraffin in high concentration has a negative effect on Urease activity. These conditions generally imply low soil fertility, which in turn implies low agricultural productivity. The measurement of urease activities provides information on the presence and activity of viable microorganisms as well as on the intensity, kind and duration of the effects of hydrocarbon pollution on soil metabolic activity. Also the results obtained it can be concluded that urease activity can be used as bioindicators of anthropogenic stress caused by oil hydrocarbons.

REFERENCE


