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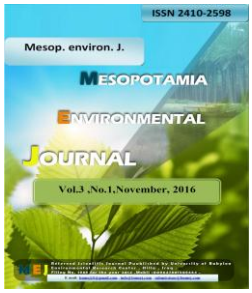

Phytoremediation of soil polluted with Iraqi crude oil by using of cotton plant

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Abstract

Remediation technology is an effective way to reduce pollutant like hydrocarbons from the environment. An experimental work was conducted at green house of University of Technology in order to investigate the impact of crude oil on the development of plant and to study and measure shoot height, germination rate and the reduction of total petroleum hydrocarbon (TPH), which result, by thy phytoremediation technology. Soil specimen were measured for TPH reduction and removal by Horiba model OCMA – 350. Five doses was used in this experiment (0% control, 10%, 30%, 50%, 75%) mg crude oil / kg soil. The maximum efficiency was obtained in treatment 50% seeded with cotton, in which cotton removed 72% of the primary TPHs from soil . Results showed that the studied plant species were promising and effective in reducing and removing TPHs from polluted fresh soil.

Keywords: Phytoremediation; Soil; Crude oil; TPH

Introduction

In the last century, numerous factors, for example rapid development of inhabitance , industrialization, the action of agriculture and the disposal of trash have remarkably contributed to increase soil pollution [1]. During the final decade, oil production have already been disposed of in the nature area surroundings supposing that the nature area will be enough to absorb them; however, this really is no longer the case and accumulating contaminants are now have an effect on the health of people [2]. Furthermore, concerns about organic

contaminants like for instance petroleum hydrocarbons have had a great part of soil contamination , which have considerably increased [3].

Among them, total petroleum hydrocarbons (TPHs) are of great interest whilst the accumulation of those compounds in soil might lead to significant risks to human through different exposure pathways [3]. The advance techniques to remediate soils polluted with organic and other toxic pollutants was considered as intense research interest recently. Although diverse biological, chemical, and physical processes were used for good remediation of polluted soil, now a days , many developing countries have almost completely relinquished remediation of oil-contaminated areas because of the great costs of conventional (chemical/physical) soil remediation procedure [4].

Phytoremediation is just a green technology that can be a hopeful treatment for hydrocarbon-contaminated soils remediation , not only in the countries that have been developed but in addition in developing countries such as Iraq, in which uncontrolled damped of oil manufacture wastes has contaminated soil resources during the final decades. The collaboration of soil microorganisms and plant roots helps the decay of permanent organic contaminants in phytoremediation. Abstraction of petroleum hydrocarbons from soil by phytoremediation technology is regularly related to microorganisms that found in the rhizosphere layer under the effect of plant roots [5-6].

Phytoremediation is in site remediation technique, which explains why some contradictory outcome have been notified about the efficiency with this techniques in abstraction pollutions from soil [6]. Using native plant species, which can be resist to high concentrations of TPHs in soil, can be quite a key aspect in the success of phytoremediation. However, the major objectives of this study were to evaluate the phytoremediation potential of cotton, in addition to its development attitudes in petroleum hydrocarbon polluted soil.

Materials and Methods

The experimental soil was chosen and collected from location without oil contamination. Then, Iraq crude oil, which was supplied and analyzed, was used to contaminate the selected soil. The following treatments were used in the experimental study:

S1: Unpolluted soil (control) sown with selected plant seeds and without seeded plant.

S2: Polluted soil with crude oil (10000 ppm, 30000 ppm, 50000 ppm and 75000) sown with seeded plants and without seeded plant.

Control soil was used to show the degradation of crud oil by microorganisms without the plant effect and compare it with planted pots to see the effect of plant on degradation . Petroleum hydrocarbon pollution have the impact on plant growth, which was discover by this comparison. In this research soil is sieved by 2 mm sieve. After mixing the soil homogeneously ,the weighted soil were transmitted to PVC pots (7 kg of soil per pot). Plants were seeded in contaminated soil as well as unpolluted soil. Then the TPH concentration will be measure in control and contaminated soil one vegetation species were employed in this phytoremediation research. However, like we know, natural processes can be used to reduce concentration of TPHs such as microbial action in soil. Its appear that , even if the contaminated soil is ignored and neglected without any treatment or remediation effort , TPH decreasing will happen after a duration . The effect of phytoremediation itself should be separated from the natural processes, which is called "Natural Attenuation". Therefore, in this

study, natural attenuation (NA) treatment was also considered for TPHs reduction. Cotton was seeded in soils S1 and S2 along a 3- month duration in a greenhouse. Six seeds of cotton were vegetated in a depth of 1 - 1.5 cm in the upper layer of soil in each pot. The pots were put into the greenhouse beneath the sunlight. The plants were irrigated two times a week to keep sufficient and constant moisture level and to minimize the generation of leachate [11] .The temperature was between 25 °C and 35 °C. Leachate was collected by PVC pans were putted beneath each pot .The collected water from the pans was putted in the next watering to avoid the loss of petroleum hydrocarbons . However, only 0.02% of the TPH in soil was leached from the pots with the excessive water that get down to the pans [12]. account the number of developed seeds or surface density monitoring was made to see the germination rate in the first weeks. The shoot height was monitored and measured. Core sampler (inner diameter = 10 mm) was used to take soil samples from the 5cm height of the pots in the beginning and end of study. For TPH measurement , soil samples were dried by air putting it at room temperature and passed through a 2 mm sieve. There are various procedure, which will accurately measure TPH in soil. This method is provided as a simple procedure for Horiba model OCMA – 350 oil concentration monitoring and analysis.

Results

A promising behavior the vegetated species that employed in this phytoremediation research in removing petroleum hydrocarbon-contaminated soil. Because of the, oil pollution plant development was depressed to some extent. Shoot height and final seedling emergence of the studied plants and results are showed in Figures 1 and 2, respectively

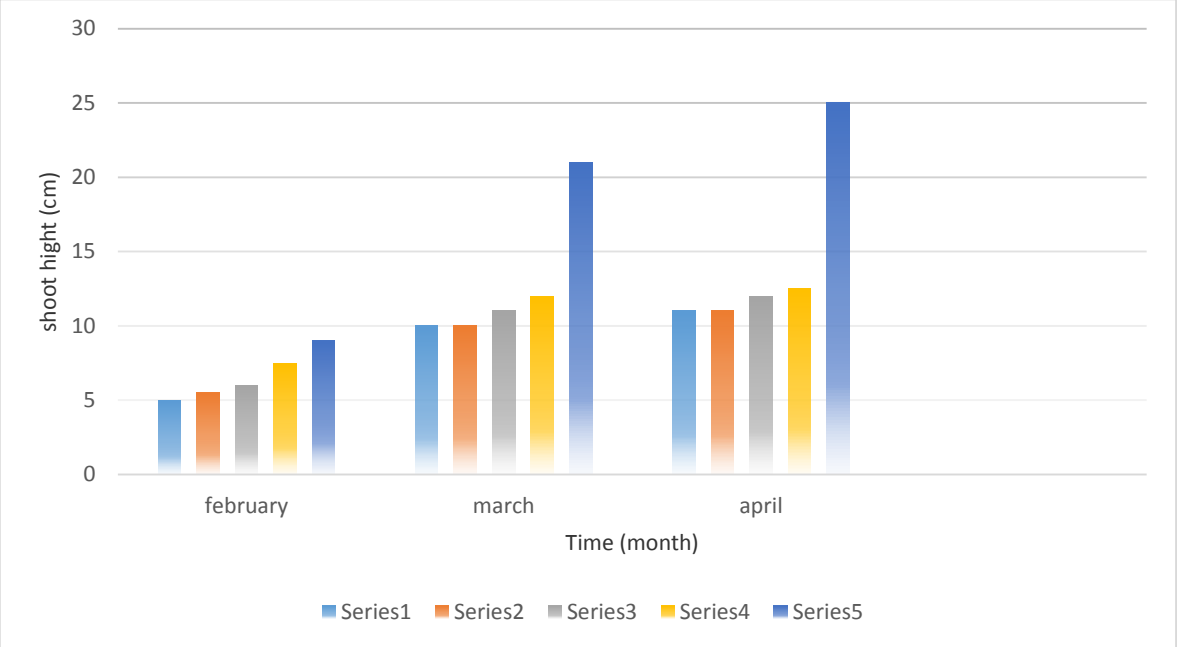

Figure 1. Shoot height monitoring during phytoremediation

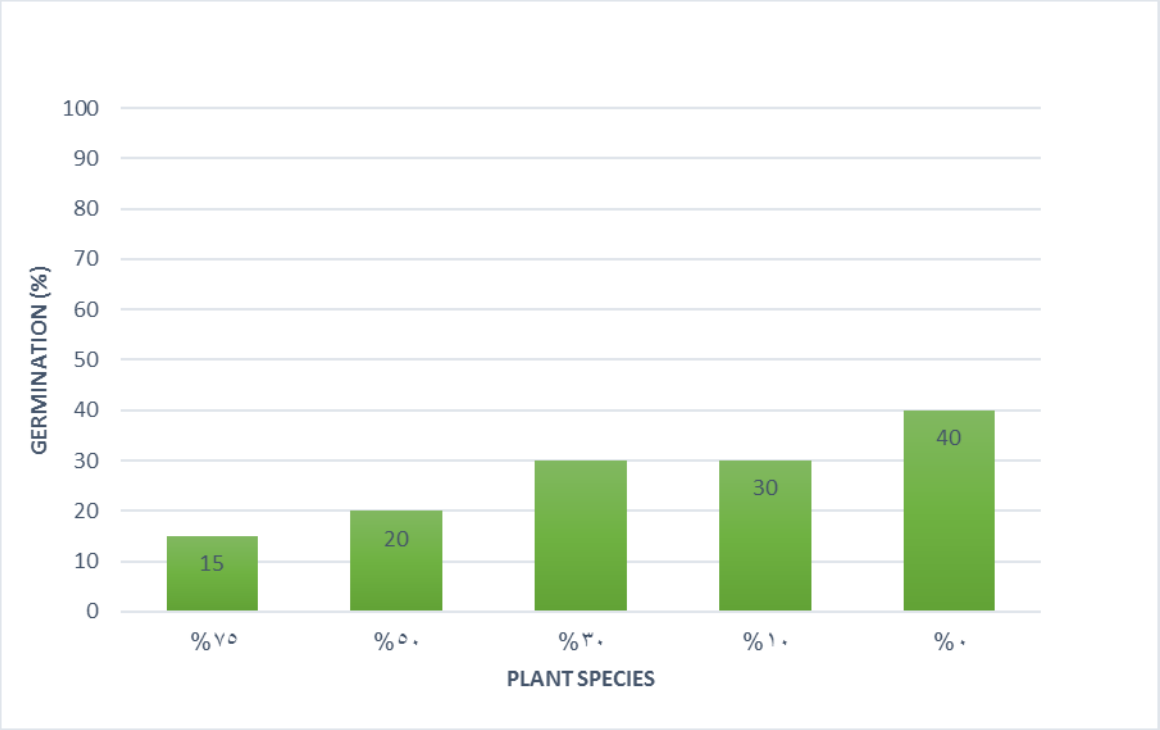

Figure 2. Emergence of plant species in soils S1, and S2

Seedling germination of cotton was frustrated caused by the petroleum hydrocarbons that exist in soil (Figure 2) . In addition, delay of seedling germination for plants vegetated in soils S2 was observed in comparative to those vegetated in control soil (S1).

The plant shoot height vegetated in oil-polluted soil were have short height in compare with the shoot height of plant grown in clean soil.

The decrease of TPH concentration was shown in Figure (3). The impact of the observed plant on petroleum hydrocarbon elimination at specific period of times was monitored . the seeded plant caused a greatly higher petroleum hydrocarbon dispersion in comparison with un vegetated soil. Natural attenuation capable of minimize the polluted degree by TPH in soil by (15%, 36%, 53.8%, 35%) for (75%, 50%, 30%, 10%) respectively crude oil concentration at the end of the study . The highest phytoremediation efficiency was obtained for cotton, in which plant presence in comparison with natural attenuation reduced TPH level by (68% ,72%, 52%, 37.7%) for (75% ,50% ,30% , 10%) respectively. Table 3 presented the TPH removal rate at one-time intervals. TPH dispersion in S2 with the existing plant was greater in the 60 days. This drift was also studied for natural attenuation. The lowest TPH depression rate was observed at the final month.

Table 3. TPH removal rate in different treatments (mg kg-1)

Treatment	Time interval (day)	Removable by plant (Concentration at the beginning - concentrating at the end -concentration removed by NA)	Removal rate by plant
Different concentration of crude oil with plant(ppm*10^3)	0-60 At the beginning- at the end		
0%	355-269	21	5.9%
10%	610-380	11	1.8%
30%	994-475	35	3.52%
50%	3876-1063.2	1384.8	35.72%
75%	4368-1356	2328	53.2%
Natural Attenuation			
0%	355-290		
10%	610-391		
30%	994-510		
50%	3876-2448		
75%	4368-3684		

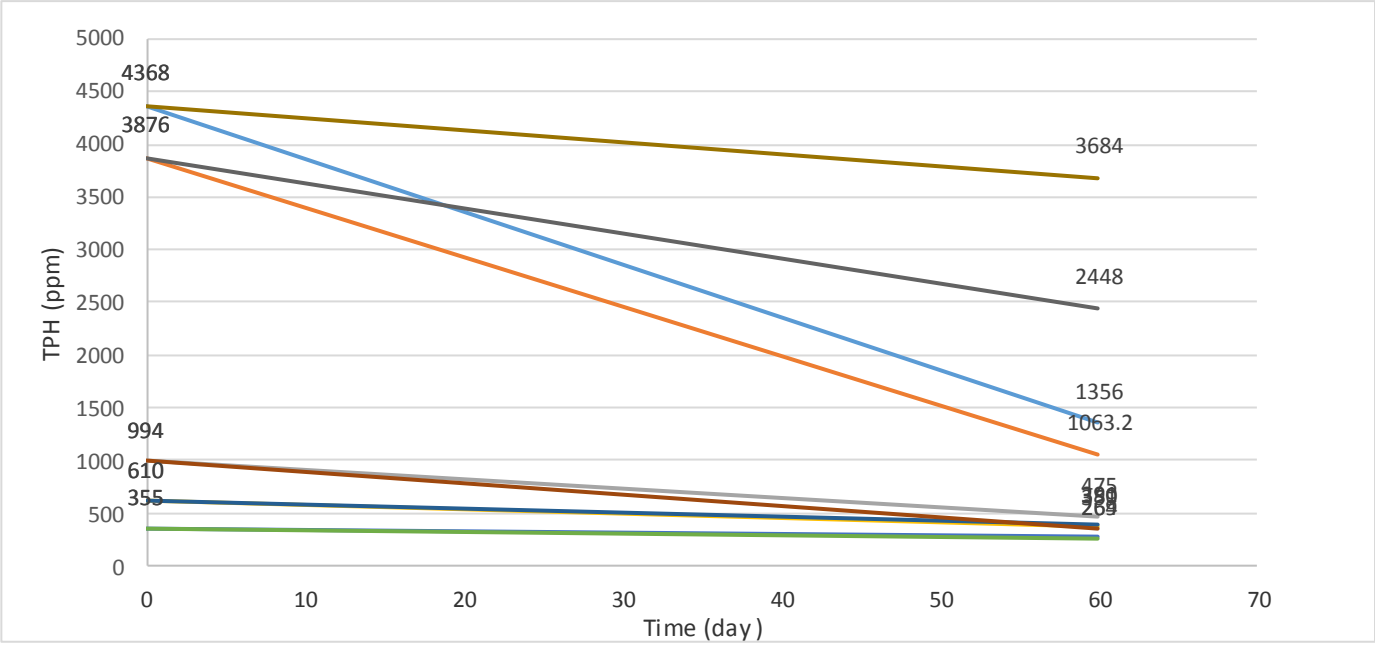

Figure 3. Residual amounts of total petroleum hydrocarbons (TPHs) in soils

Discussion

A promising behavior was showed by the plant species, which was used in the current phytoremediation study in petroleum hydrocarbon-polluted area . However, the plant development was frustrated in oil pollution soil to some extent. The most substantial point in plant establishment is the development rate. Germination Sensitivity also the first development steps of seeding plant can infuence the efficiency of phytoremediation. A relationship between poor emergence and subsequent poor development in hydrocarbon-polluted area was mentioned by some reserch [10].

An adverse effect and delay caused by the increase of petroleum hydrocarbon concentration on development of the observed plant species; In addition, the subsequent evolution was frustrated greatly in most cases by petroleum hydrocarbon contamination .

The soil employed in this research was fresh soil , refer to the fresh oil pollution . The water repellent characteristic of hydrocarbons may be the cause of development delay of the studied plants. Delaying or preventing the access of water and oxygen to seeds may cause by the Hydrocarbons, which was, perform as a physical barrier [7].

The presence of petroleum hydrocarbon made a remarkable reduction of shoot height, which was observed for cotton plants .The toxic effects of petroleum hydrocarbons caused an Inhibition of plant growth. Small molecules of hydrocarbons can enter and pass cell membranes leading to decrease membrane integrity or even to death of the cell [13].

Plant health can be indicate by plant height and shoot biomass; however, greater shoot biomass measurements are not necessarily indicative of enhanced remediation efficiency [8]. Extensive root elongation is likely to be associated with more root biomass with in the soil.

It was observed that the studied plants increase the removal rate of petroleum hydrocarbon at varied sampling times. The seeded plant made a significantly higher petroleum hydrocarbon dispersion in contrast with unplanted soil.

Based on the obtained results, cotton is promising species for phytoremediation of fresh, petroleum hydrocarbon-contaminated soils. However , plants growth was depressed by petroleum hydrocarbon contamination . Cotton as we know it is easy to vegetate in many countries. Remediation is well known as inexpensive and required minimum maintenance technology which is why it used in Iraq and most developing countries .

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