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ORIGINAL ARTICLE

Possibility of Using *Conocarpus lancifolius* Engl. in Remediation of Some Iraqi Soils Polluted by Crude Oil

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ABSTRACT
Iraq is one of the main oil producing countries in the world. Soil is sometimes exposing to pollution through the processes of production, piping, transporting, and refining of crude oil. Remediation of such polluted soils is not applying in the country yet. In this research, we suggested the use of new-introduced species Conocarpus lancifolius Engl. in soil phytoremediation. Two types of soil treated with five levels of crude oil pollution were the substrate in which forty seedlings were replanted. Experiment lasted 8 months during which plants were daily irrigated and observations were recorded. Results showed that plants could survive even under the highest pollution level (10%). Depression in growth parameters occurred largely by the addition of 2.5% oil, then it was little with increasing oil percent. Although sandy soil appeared more favorable than clayey one to C. lancifolius, pollution had more impact upon it that made the end growth in both polluted soils not far from each other. Pollution highly affected number of branches during hot months through its retarding from May until September. Unpolluted plants continued growing even though the absolute maximum temperature exceeded 48 ºC. The addition of 10% of crude oil resulted in declining of growth parameters at the end of experiment between 21% - 62% depending on the specific property. Shoot weight was the most affected property by high pollution. From results, it was concluded that C. lancifolius could survive under certain levels of crude oil pollution in Iraqi soils. Further studies were recommended to investigate the capability of the species in degrading total petroleum hydrocarbons in rhizosphere.
***Keywords**: Conocarpus lancifolius, Crude oil, polluted soils*

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INTRODUCTION

During the last ten years, Iraqis observed a presence of uncommon plant inside cities. It is evergreen, fast growing, shiny- green color, that is the new introduced species *Conocarpus lancifolius* Engl.. Private nurseries brought the plant from Arab Gulf countries to Basra from which it crawled to Baghdad via all of southern and middle governorates.

The natural distribution of *C. lancifolius* is Southern Yemen, Somalia, and introduced to Sudan, India, Syria, Yemen, Djibouti, Northern Kenya and Pakistan [1]. It is one of the fastest growing trees, producing large quantities of firewood, providing strong poles and timber, useful for housing construction [2]. Trees are useful for stabilizing riverbanks and improving poor, nutrient-deficient soil; and as ornamental shade trees and windbreaks around irrigated farms [2].

Botanically, *Conocarpus* is a genus of two species of flowering plants in the family Combretaceae, native to tropical regions of the world. One of the species (*Conocarpus erectus*) is a widespread mangrove species, the other (*Conocarpus lancifolius*) is restricted to a small area around the southern Red Sea coasts, where it grows alongside seasonal rivers. Botanical classification is as follows: Kingdom: Plantae, Division: Tracheophyta, Class: Magnoliopsida, Order: Myrtales, Family: Combretaceae, Genus: *Conocarpus* [3].

The species *lancifolius* thrives in hot conditions. Once its root system is established, it will survive on as little as 100 mm rainfall in deep sandy soils [2], and referred that its growth is slow on dry sites, and it must have a high water table, and also it tolerates flooding, saline conditions, sand, clay and very shallow soils over coral rock. It was found [4] to tolerate a moderate soil water stress over a long period rather than a severe stress for a short time.

It is evergreen tree grows up to 20 m in height and 60 to 250 cm in diameter under favorable climatic conditions [5]. Leaves are dark green, simple lanceolate, showed xerophytic characteristics, low relative water content and high trichome density on younger leaves [6]. Epidermis covered with non- glandular simple hairs and glandular multicellular hairs [7]. Some studies focused on its tolerance to salinity and draught conditions [8; 9; 10; and 11], even the possibility of using saline drainage effluent. Few studies were carried out in some oil producing countries to use the plant as remediating agent for oil-polluted soils [12; 13; 14 and 15]. In Iraq, very limited studies have conducted on the species in the areas where it has introduced. In Basra (First city embraced the plant), it was important to know the most convenient method for propagation [16], and the anatomy of leaves which may assist the plant in resistance of hot dry climate conditions [7]. Seedling fertilization was the research matter of other study elsewhere in the country[17]. No more works on the species are there because of its short history in our lands.

Remediation of contaminated soils is often performing by using some plant assisting in reducing the harmful effect of contaminants. This environmental remediation technique is called phytoremediation. Its success depends on the extent of soil contamination, accessibility of contaminants for rhizosphere microorganisims, and the ability of the plant and microorganisms to intercept, absorb, accumulate, and/or degrade the contaminant [18]. Some studies searched with this field and assured validity of some plants for phytoremediation [12; 19 and 20]. In Arab peninsula where oil producing lands, some related studies were carried out [13; 14 and 15]. Despite the rather extensive studies that have been carried out worldwide regarding Phytoremediation of oil polluted soils, some contradictory results have been reported regarding the efficiency and performance of this technology in removing contaminants from soil [21].

Since Iraq is one of main oil producing countries exposing to pollution through producing, transporting, and refining processes, and because of lack of studies on phytoremediation, this research has conducted to explore the resistance of *C. lancifolius* to different levels of crude-oil pollution. It is first step in studying the possibility of using this plant in phytoremediation of such Iraqi polluted soils.

MATERIALS AND METHODS

Six months-old seedlings of *Conocarpus lancifolius* were brought from private nursery around Baghdad city to the experimental field of natural history research center and museum, University of Baghdad. They were replanted in larger polyethylene pots filled by 8 kilograms of one from the two types of soil. Twenty pots were filled by heavy soil, other twenty by sandy soil. Four levels of Basra crude oil were used for soil pollution (2.5, 5.0, 7.5, and 10.0) percentage. Each treatment replicated four times. Four pots from each of soil types were left without treatment as control for comparison. According to the level of pollution, specific amount of oil was gently mixed with soil before planting. Treatments commenced at 1st February 2013. Seedlings were daily irrigated by same amount of water for 240 days. Plant over ground parameters and abnormal symptoms were recorded directly after planting and periodically. After eight months (complete growth season), the experiment was ended and growth parameters of shoot (plant length, number of branches, green weight, dry weight) and roots (root length, green weight, dry weight) were taken. The experiment was designed as factorial CRD; Soil type: 2 levels, Oil pollution: 5 levels, and 4 replications. Data were analyzed statistically by Statistica 99 Edition [22].

RESULTS AND DISCUSSION

Shoot-length and number of branches as a function of growth development were recorded at the end of each month of the growing season. Table (1) shows the average values of these two variables in relation to soil type and level of pollution. Shoot length continued increasing until the end of experiment. Its increment was dependence upon soil type, pollution level, and time within growth season. Growth, practically, started in March, then increased gradually until hot summer months during which excessive rates

Table 1: Effect of different levels of crude oil pollution on shoot length and number of branches of *Conocarpus lancifolius* seedlings.

C L A Y E Y S O I L								
Pollution	1st Feb.	30th March	30th April	30th May	30th June	30th July	30th August	30th Sept.
	Shoot Length (cm)							
C0 (0 %)	30.75	31.25	35.00	42.00	49.75	64.25	75.75	92.00
C1 (2.5 %)	39.00	39.50	42.50	44.50	47.25	50.50	61.25	72.00

C2 (5.0 %)	42.00	43.00	45.00	49.00	47.25	51.00	54.50	62.50
C3 (7.5 %)	38.75	39.25	42.25	45.75	44.75	44.75	49.00	57.75
C4 (10 %)	30.00	31.25	34.50	39.75	40.50	41.50	45.25	55.25
Mean Number of Branches								
C0 (0 %)	6.50	7.25	10.50	12.75	13.25	16.25	18.25	18.25
C1 (2.5 %)	11.25	11.75	14.00	13.50	11.00	10.50	14.00	14.00
C2 (5.0 %)	9.75	11.00	12.57	12.50	10.25	9.00	10.25	9.50
C3 (7.5 %)	7.50	8.25	10.50	11.00	11.00	10.00	8.75	9.00
C4 (10 %)	7.75	9.25	10.50	10.00	9.00	6.75	7.25	6.50
S A N D Y S O I L								
Pollution	Shoot Length (cm)							
S0 (0 %)	33.7	33.9	35.0	48.5	41.5	91.8	105.0	116.5
S1 (2.5 %)	34.5	34.3	35.0	39.0	40.8	46.0	57.8	67.5
S2 (5.0 %)	34.0	34.9	34.8	38.5	42.0	50.3	57.5	68.8
S3 (7.5 %)	41.3	42.2	43.0	49.0	48.5	51.0	54.2	60.5
S4 (10 %)	42.8	42.9	44.5	46.3	47.8	49.0	49.5	58.0
Mean Number of Branches								
S0 (0 %)	8.0	9.3	10.5	14.8	18.3	23.3	25.8	28.8
S1 (2.5 %)	8.0	8.8	9.5	10.8	10.0	8.5	15.0	11.8
S2 (5.0 %)	11.3	12.5	13.8	12.3	12.0	11.5	14.8	14.5
S3 (7.5 %)	10.5	10.8	12.5	14.5	11.3	9.5	9.5	9.0
S4 (10 %)	9.0	10.3	12.8	12.3	10.3	9.3	9.5	7.3

of growth has obtained. This trend was clearer in unpolluted plants for both of soil types. The result supported literatures talking that the species thrives well in hot climates [1, 5, 23]. Sandy soil showed priority as compared to clay one. However, when it has been polluted by oil this priority disappeared. While plants of (S0) attained 246 % excessive shoot length, plants of (S1) could not grow more than 96 % their original lengths (i.e. ratio between S0 and S1 in sandy soil was about 1: 2.5). In clay soil, similar ratio has obtained.

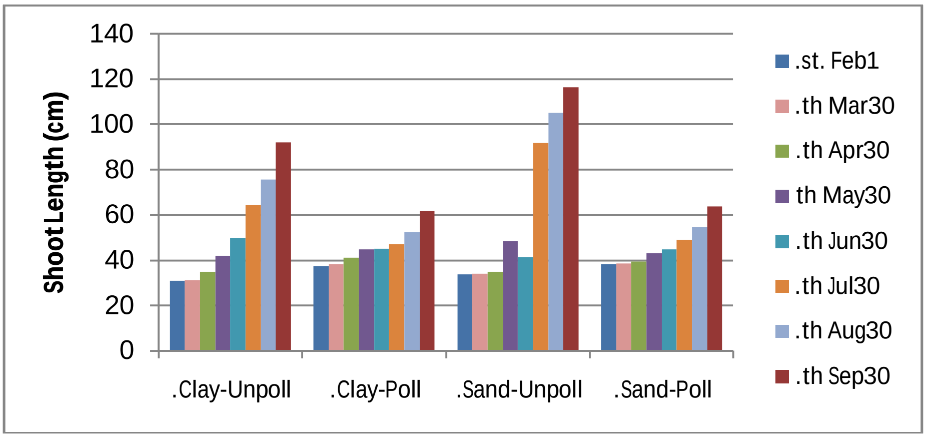

Figure 1: Mean difference in shoot length between polluted and unpolluted soils.

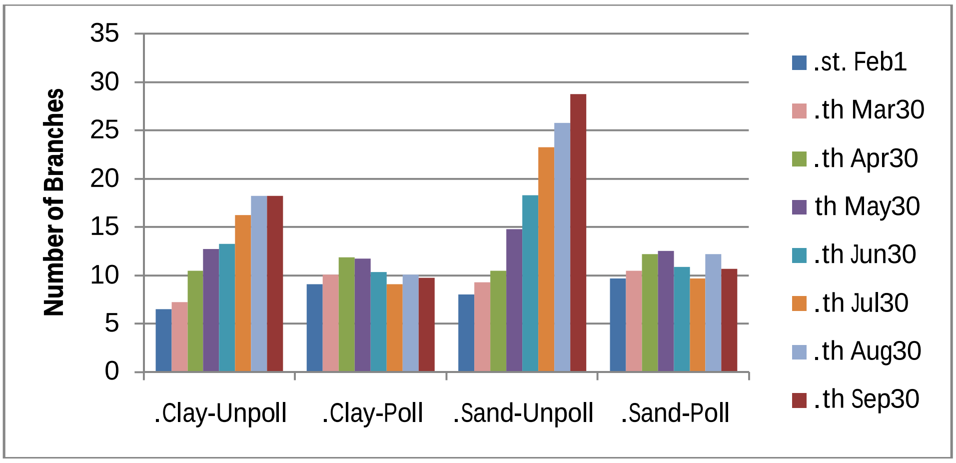

Figure 2: Mean difference in number of branches between polluted and unpolluted soils.

The trend was different with branches. After two or three months, number of branches decreased through the death of some of them. Declining in branches number was most obvious in higher pollution levels. Continuous field observation approved that weakening of polluted plants started with the beginning of hot summer months. Final number of branches of unpolluted plants was 3 times that of (C4) in clay soil, and 4 times that of (S4) in sandy soil. The number of branches increased from the beginning until May, after which it started decreasing by weakening, yellowing, and death of some lower branches. Figures 1 and 2 show the comparison between treated and untreated plants. In these two figures, mean value of shoot length or number of branches of polluted plants has computed regardless to level of pollution. From histogram, it was clear that both variables in polluted plants substantially decreased

Figure 3: Shoot and root sizes of *Conocarpus lancifolius* as affected by soil type (S: sand and C: clay) and crude oil pollution (L0, L1, L2, L3, L4).

Table 2: Growth parameters of *C. lancifolius* seedlings grown in sandy soil as affected by crude oil pollution.

Property	Level of Pollution								
	L0 (control)	L1 (2.5%)		L2 (5.0%)		L3 (7.5%)		L4 (10.0%)	
	Mean	Mean	(%)*	Mean	(%)*	Mean	(%)*	Mean	(%)*
Shoot Length (cm)	116.50 (A)	67.50 (B)	58	68.75 (B)	59	60.50 (B)	52	58.00 (B)	50
Number of Branches	28.75 (A)	11.75 (B)	41	14.50 (B)	50	9.00 (B)	31	7.25 (B)	25
Shoot Green Wt. (gm)	160.50 (A)	45.00 (B)	28	66.50 (B)	41	45.00 (B)	28	33.00 (B)	21
Shoot Dry Weight (gm)	70.93 (A)	17.05 (B)	24	32.03 (B)	45	23.18 (B)	33	18.10 (B)	26
Root Length (cm)	54.75 (A)	45.75 (AB)	84	38.50 (B)	70	35.00 (B)	64	31.25 (B)	57
Root Green Wt. (cm)	81.38 (A)	61.80 (A)	76	56.75 (A)	70	53.50 (B)	66	40.50 (B)	50
Root Dry Weight (gm)	41.50 (A)	28.60 (A)	69	36.17 (A)	87	33.45 (A)	81	20.25 (B)	49

Note: Means having same letters have no significant differences at $P \leq 0.05$.
(*): Percent from control

during hot summer months. In contrast, unpolluted plants continued growing even though the absolute maximum temperature exceeded 48 ºC [24]. The difference between treated and untreated plant in sandy soil was more than in clayey one (Figure 3).

Growth parameters recorded at the end of experiment (Tables 3, 4) showed that the effect of oil pollution was more significant than the second factor (soil type). While the first affected all measured parameters, the second showed different levels of significances

on some of them. Soil affected more in weight related parameters than in shoot dimensions. Comparison between the two-soil types showed that all properties of plants grown in sandy soil exceeded their equivalents in clay soil by 9% to 135%.. The two higher pollution levels (L3, L4) affected more than the first two. Depression percents in tables referred that largest depression in almost all parameters occurred

between L0 to L1, then little or no significant change with excessive addition of oil. Duncan's multiple range test of pollution levels (L1-L4) showed either little or no significant differences between these four levels, that was depending on the property being investigated . The result indicated that the species *C. lancifolius* could tolerate pollution in soil by crude oil between 2.5 – 10 % . The maximum effect of L4 was on shoot weight where it recorded 21% to 29% the weight of control for both types of soil.
The retarding action of pollution on growth was more regular in clayey soil while in sandy soil the maximum amount of depression occurred through the addition of 2.5% of oil, and then the depression was gradual with increasing oil percent in the soil. By the addition of 2.5% of oil, 42% of the shoot length

Table 2: Growth parameters of *C. lancifolius* seedlings grown in clayey soil as affected by crude oil pollution.

Property	Level of Pollution								
	L0	L1		L2		L3		L4	
	Mean	Mean	(%)*	Mean	(%*)	Mean	(%)*	Mean	(%)*
Length of Plant (cm)	92.00 (A)	72.00 (AB)	78	62.50 (AB)	68	57.75 (B)	63	55.25 (B)	60
Number of Branches	19.75 (A)	14.00 (AB)	71	9.50 (B)	48	9.00 (B)	46	6.50 (B)	33
Shoot Green Wt. (gm)	97.25 (A)	55.25 (B)	57	43.50 (B)	45	36.00 (B)	37	25.50 (B)	26
Shoot Dry Weight (gm)	39.43 (A)	21.70 (B)	55	17.78 (BC)	45	17.83 (BC)	45	11.53 (C)	29
Root Length (cm)	57.25 (A)	62.75 (A)	110	50.00 (A)	87	34.50 (B)	60	29.75 (B)	52
Root Green Wt. (cm)	47.75 (A)	36.50 (AB)	76	22.25 (BC)	47	30.00 (ABC)	63	17.25 (C)	36
Root Dry Weight (gm)	23.75 (A)	16.25 (AB)	68	13.20 (BC)	44	14.70 (B)	62	6.20 (C)	27

Note: Means having same letters have no significant differences at $P \leq 0.05$.
(*): Percent from control

was reduced in sandy soil, while in clayey one the reduction was only 22%. Clay soil showed better tolerance to the mild pollution. Some growth parameters exhibited no significant differences between some pollution levels with control or between pollution levels themselves.
Results of research suggested that *C. lancifolius* could survive under certain levels of pollution by crude oil in Iraqi soils. Difference in soil structure and texture, of course, reveals to different findings. While the species has the ability of degrading total petroleum hydrocarbons (TPH) and it uptakes high levels of pollutants (13, 14, 15), it could be regard as a promising species in phytoremidation of some Iraqi polluted soils. More studies on the ability of the species to degrade (TPH) in Iraqi soils could assist in realizing more precise conclusions.

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