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Research Article

Use of three local plant species in the treatment of crude oil-contaminated soils in the north of Basrah Governorate

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Abstract: The study was conducted in one of the private fields in Al-Madinah district, north of Basrah Governorate, during the growing season 2022-2023. The study included two factors: four concentrations of crude oil, which are 0, 50, 100, and 150 (g. kg-1soil) and the second factor, three plant species, Tamarix aphylla L., Cestrum nocturnum L., and Catharanthus roseus L.. The number of treatments was 12 treatment with three replications. The Randomized Complete Block Design (R.C.B.D) was applied using the Least Significant Difference (L.S.D) Significant Differences Test at least the level of probability 0.05 using the GeneStat program. The analysis results showed that an increase in the concentration of crude oil in the soil led to a decrease in vegetative and physiological traits, plant height, stem diameter, leaves number, leaf content of chlorophyll and total soluble carbohydrates, with an increase in the concentration of crude oil. Plant species differed in their accumulation of petroleum hydrocarbons. The highest concentration of hydrocarbons appeared in the plants of the Cestrum nocturnum L., as it reached, and the lowest concentration in the plants of Catharanthus roseus L., as the results showed that the highest percentage of total plant treatment was at a concentration of 50 g. kg-1 soil. As for the average effect of the plant type, Cestrum nocturnum plants excelled in the percentage of treatment, as it reached compared to plants Catharanthus roseus L., which reached, which did not differ significantly from Tamarix aphylla L. plants in the percentage of treatment, as it reached, and the interaction between the type of plant and the concentration of oil had a significant effect in the percentage of treatment. Cestrum nocturnum plants treated with a concentration of 50 g. kg-1 soil, gave the highest treatment percentage, compared to the lowest treatment percentage, which resulted from Catharanthus roseus L. plants, and treated with a concentration of 150 g. kg-1 soil.

Keywords: Crude oil; tamarix aphylla L; Cestrum nocturnum L., Catharanthus roseus L.

INTRODUCTION

Petroleum hydrocarbon compounds are among the most important environmental pollutants, as they harm most forms of life (Al-Ali *et al*., 2016; Abha and Singh, 2012). These pollutants reach the environment through exploration, transportation, various industrial activities, spills, and gas emissions (AL.Atbee, 2018) Basrahh Governorate is the first producer and source of oil in Iraq (Aljamee *et al*., 2020). Soil pollution, especially agricultural, has raised the concern of those interested in this field because of the accumulation of oil pollutants and the hydrocarbons they contain and heavy elements and their transfer to crops and their entry into the food chain, which poses a threat to human health (Huang *et al*., 2007) as petroleum hydrocarbons affect soil permeability and soil quality Water works to inhibit the activity of microorganisms and causes a change in the chemical composition of the soil and its availability of nutrients (Abbasian *et al*., 2016).

Environmental pollutants inhibit the metabolic processes of plants, such as photosynthesis, carbohydrate formation, gaseous exchange, and respiration, by destroying mitochondrial membranes and deteriorating the natural activity of biological systems (Ghalachyan *et al*., 2014). Balasubramaniyam and Harvey (2014) indicated that contamination of soils with crude oil leads to a decrease in their abundance of nutrients, and (2018) *et al*. Taheri, when treating eucalyptus plants using four concentrations of crude oil, that increasing the concentration of crude oil led to a decrease in plant height, stem diameter, and number of leaves with an increase in oil concentration. In a study conducted by (Fasial *et al*. (2020) on the impact of oil pollution resulting from the oil fields north of Basrah Governorate, the results showed that there is a difference in the concentration of hydrocarbons and the elements lead and cadmium in date palm leaves according to the location of the study. Where its location is from the oil wells, and the results showed that the oil pollutants affected the thickness of the cuticle layer and the thickness of the upper and lower epidermal cells, and the thickness increased and led to a

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decrease in the chemical properties of the fruits of the date palm, the Jebjab variety.

As shown by Ramos *et al*. (2009), in his study on the phytoremediation of petroleum hydrocarbons using Sebastiania commersoniana, with three crude oil concentrations of 25, 50, and 75 g. KG-1, the removal rate reached 60%. Al-Tamimi (2021) indicated that plant species differ in their tolerance and ability to treat oil pollution when studied on *Parkinsonia aculeata* L. and *Acacia farnesiana* L. using concentrations of 20, 40, and 60 g. kg of crude oil, as it indicated a decrease in vegetative growth indicators and a high The plant, stem diameter, number of leaves, leaf content of chlorophyll and total soluble carbohydrates, and between the superiority of *Acacia farnesiana* L plant in the total percentage of soil treatment of crude oil, and to increase oil pollution in the north of Basrah Governorate due to the presence of many oil wells, and to reduce the impact of these pollutants, phytoremediation was used as a promising and easy method The application and low costs through the absorption of pollutants by the plant and treatment in different ways, so the study was conducted to find out the efficiency of three local plants suitable for living in the environment of Basrah, namely *Tamarix aphylla*, L. queen of the night, *Cestrum nocturnum*, and the eye of the cat plant *Catharanthus roseus* L. in remediation of soil contaminated with crude oil.

MATERIALS AND METHODS

The study was conducted in one of the private fields in Al-Madinah district, north of Basrahh Governorate, during the growing season 2022-2023. The study included two factors: four concentrations of crude oil, namely 0, 50, 100, and 150 (g. kg^{-1} soil), and the second factor, three plant species: *Tamarix aphylla* L. and *Cestrum nocturnum* L., and *Catharanthus roseus* L. The number of treatments was 12, with three replications, and the number of experimental units was 36. Thirty-six pots with a diameter of 35 cm were prepared and filled with soil from the areas near the oil fields of West Qurna 2 and treated with crude oil concentrations from west Qurna 2 at a rate of 10 kg of soil per pot. On 01.11.2022, seedlings of the above plants, one month old, were prepared from one of the private nurseries in the city district and planted in pots according to the design of the experiment. All agricultural operations followed in cultivating these plants were carried out, including fertilization, as they were fertilized with urea fertilizer at 120 kg ha, and irrigation using Reverse (R.O) water. Osmosis Soils were analyzed before planting. Table (1) represents the chemical properties of soils before planting.

Table (1) some physical and chemical properties of soil in the field

Soil	Value
E.C (des m^1)	2.74
PH	7.42
Available P (Mg. g^{-1})	0.0028
Available N (Mg. g^{-1})	0.023
Available K (Mg. g^{-1})	0.56
TPH (Mg . g^{-1})	7.6
Soil texture	
Sand	18.62
Silt	35.73
Clay	46.65
Texture	Clay loam

The Randomized Complete Block Design (R.C.B.D) was applied with a factorial experiment, and the results were analyzed using the least significant difference test using the statistical program GeneStat to compare averages at the probability level of 0.05 (Al-Rawi and Khalafallah, 1980). The study indicators were measured:

It included the following:-

1- Measurement of plant height, stem diameter, and a number of leaves: Measurement was done for two periods after 90 days and 180 days.

2- Estimation of the leaf content of chlorophyll pigment and carbohydrates, and the evaluation was done for two periods after 90 days and 180 days.

3- Estimating the concentration of hydrocarbons in the shoot and root system at the end of the experiment

4- Estimating the phytoremediation (removal) of hydrocarbons from the soil, and the estimate was made at the end of the experiment.

RESULTS AND DISCUSSION

Indicators of vegetative growth

Table (2) shows that the plant type and the concentration of crude oil in the soil significantly affected the indicators of vegetative growth (plant height, stem diameter, and number of leaves) for the two stages of measurement. For measurement, the lowest height of the plants, the least diameter of the stem, and the lowest number of leaves were 53.67 cm, 9.39 cm, and 35.89 cm, respectively, and for the second stage of measurement, it was 61.38 cm, 11.57 cm, and 46.67 cm, respectively. As for the average effect of plant type, *Tamarix aphylla* plants were significantly superior to *Cestrum nocturnum* and *Catharanthus roseus* L. for the first measurement stage in plant height and number of leaves, reaching 88.83 cm and 73.43 leaves plant, respectively. The second stage reached 105.78 cm, and 93.83 leaves plant on respectively, while *Cestrum nocturnum* plants gave the largest stem diameter of 12.14 cm for the first measurement stage and 14.78 cm for the second measurement stage. The interaction between crude oil concentrations and plant type significantly affected the vegetative traits under study for both stages of measurement. The highest values were in plant height and number of leaves in *Tamarix aphylla* plants and the lowest in *Catharanthus roseus* L. As for the stem diameter, the highest values were in *Cestrum nocturnum* plants and the lowest in *Catharanthus roseus* L plants. The vegetative growth of the plants showed their tolerance to the concentration of crude oil, noting The decrease in vegetative growth indicators with the increase in the concentration of crude oil, and the reason may be due to the role of hydrocarbons in hindering water absorption, which leads to drought (Kirk *et al*., 2005), and preventing the entry of air, which leads to suffocation of the roots (Amusat *et al*., 2016). or to The effect of hydrocarbon pollutants on the readiness and absorption of nutrients Balasubramaniyam and Harvey (2014) or due to the heavy elements present in crude oil and their negative impact on many different metabolic activities such as photosynthesis, respiration, and water relations (Zornoza *et al*. 2002) And in cell division and expansion (Nalini and Chandra, 2002). This is in agreement with Taheri *et al*. (2018) on Eucalyptus camaldulensis and with Al-Tamimi (2021) on plants (Parkinsonia aculeata and Acacia farnesiana).

Table (2) Effect of plant type and soil contaminated with crude oil on vegetative growth indicators

Plant type	**crude oil concentration**	**first stage**			**second stage**		
		plant height (cm)	Stem diameter (cm)	leaves number	plant height (cm)	Stem diameter (cm)	leaves number
Tamarix aphyllatamarisk	0	102	12.96	84.03	131.17	14.64	120.00
	50	94.3	11.63	76.03	112.27	13.66	93.00
	100	81.33	9.69	72.33	90.53	11.60	82.33
	150	77.66	8.76	61.33	88.43	11.23	80.00
Cestrum nocturnum	0	71.33	13.59	43.29	86.40	16.31	50.00
	50	69.00	12.96	41.23	83.33	15.19	47.67
	100	66.33	11.32	33.00	76.67	14.27	40.33
	150	55.67	10.68	32.33	65.17	13.35	38.67
Catharanthus roseus	0	41.00	10.28	28.67	57.39	10.70	29.00
	50	31.00	9.72	17.62	43.07	10.30	25.33
	100	33.00	9.12	16.97	41.30	10.45	22.67
	150	29.00	8.72	14.00	30.53	10.14	21.33
LSD.0.05		4.53	0.793	3.00	1.74	1.14	4.33
Plant type	tamarix aphylla	88.83	10.83	73.43	105.78	12.78	93.83
	Cestrum nocturnum	65.58	12.14	37.46	77.89	14.78	44.17
	Catharanthus roseus	33.25	9.46	19.31	43.07	10.40	24.58
LSD.0.05		2.26	0.396	1.50	0.87	0.57	2.16
oil concentration	0	71.44	12.27	52.00	91.65	13.88	66.33
	50	64.78	11.44	44.96	79.79	13.05	55.33
	100	60.22	10.13	40.77	69.50	12.11	48.44
	150	53.76	9.39	35.89	61.38	11.57	46.67
LSD.0.05		2.62	0.457	1.73	1.00	0.65	2.50

Physiological traits

Table (3) shows that the two study factors had a significant effect on the content of leaves of chlorophyll, total soluble carbohydrates, and proline acid for the first and second measurement stages, where the increase in the concentration of crude oil in the soil led to a significant decrease in the content of leaves of total chlorophyll pigments and total soluble carbohydrates and an increase in the concentration of proline acid, as the concentration of 150 g kg of oil was recorded.

Table (3) Effect of plant type and crude oil concentration on some physiological characteristics of plants

Plant type	**oil concentration**	**first stage**	**second stage**

	(ml kg)	chlorophyll	carbohydrates	chlorophyll	carbohydrates
tamarix aphylla	0	121.15	114.43	115.94	117.37
	50	118.63	111.24	115.18	107.29
	100	117.92	104.11	115.10	100.15
	150	107.97	96.93	103.96	91.84
Cestrum nocturnum	0	185.83	137.11	177.63	145.26
	50	185.90	132.19	172.71	135.58
	100	166.97	120.59	159.00	115.54
	150	165.47	116.03	156.33	102.84
Catharanthus roseus .L	0	165.66	117.14	152.67	125.00
	50	161.88	113.12	150.33	111.84
	100	149.00	104.00	143.51	92.51
	150	146.62	99.85	141.11	94.88
LSD.0.05		4.10	1.64	10.05	3.48
Plant type	tamarix aphylla	116.42	106.68	112.55	104.16
	Cestrum nocturnum	176.04	126.48	166.42	124.80
	.Catharanthus roseus L	155.79	108.53	146.91	106.20
LSD.0.05		2.05	1.90	5.02	4.02
oil concentration	0	157.55	122.89	148.75	129.40
	50	155.47	118.85	146.08	118.24
	100	144.63	109.57	139.20	102.73
	150	140.02	104.27	133.80	96.51
LSD.0.05		2.37	3.29	5.80	6.96

The lowest content of chlorophyll in the leaves for the two periods amounted to 140.02 and 133.80 compared to the control treatment that gave 157.55 and 148.75, respectively, and the lowest concentration of carbohydrates for the two periods reached 104.27 and 96.51 compared to the control treatment gave the highest concentration of carbohydrates 122.89 and 129.40, respectively. *Cestrum nocturnum* plants showed the highest content of chlorophyll and carbohydrates for the first period, which amounted to 176.04 and 126.48. As for the second period, the highest content of chlorophyll and carbohydrates was recorded in *Cestrum nocturnum* plants, amounting to 166.42 and 124.80, respectively. The interaction between crude oil concentrations and plant type showed a significant effect on physiological characteristics Understudy and for both stages of measurement, as the highest values were in the leaf's content of chlorophyll and carbohydrates when *Cestrum nocturnum* plants with a concentration of 0 g. How much oil and the lowest values were found in *Tamarix aphylla* at a concentration of 150 g kg, while the highest proline acid was at the treatment plant at 150 g kg.

The results of Table (3) show that the content of leaves of chlorophyll pigment and total soluble carbohydrates decreased with the increase in the concentration of crude oil in the soil. This decrease may be attributed to the effect on the biosynthesis of chlorophyll as a result of the inhibition of enzymes necessary to build chlorophyll, such as amino levulinic acid dehydratase and proto-chlorophyllide reductase Or to the effect of pollutants on the absorption of magnesium and iron, which are necessary for the synthesis of chlorophyll (Elloumi *et al*., 2014), or its effect on an increase in the concentration of proline, which works to withdraw the nitrogen element necessary for the construction of chlorophyll in favor of the construction of proline (Cha-um and Kirdmanee, 2009) or due to An increase in the production of reactive oxygen species (ROS), which caused disruption of the functions of cell components such as cell membranes and nucleic acids, led to a decrease in the process of photosynthesis (Doganlar *et al*., 2012), which affected the carbohydrate content of the leaves.

Total hydrocarbons concentration (µg g^{-1})

Table (5) shows the effect of oil concentration and plant type on the total content of hydrocarbons in the root and shoot groups, as it was observed that increasing the concentration of crude oil led to an increase in the total content of hydrocarbons in the root and shoot groups, as it reached the highest content at a concentration of 150 g kg of oil in the root group 52. 80 µg g-1, and in the shoot total it was 31.10 µg g-1 compared to other treatments. As for the average effect of the plant type, *Cestrum nocturnum* plants were significantly superior in this capacity in the root and shoot total, reaching 30.59 and 43.99 µg g-1, respectively.

Plant type	hydrocarbons concentration in the roots	hydrocarbons concentration in the leaves
	oil concentration (g. kg^{-1})	oil concentration(g. kg^{-1})

	0	50	100	150	Plant effect	0	50	100	150	Plant effect
tamarix aphylla	12.51	28.84	38.69	50.88	22.77	9.25	22.66	24.96	34.21	32.74
Cestrum nocturnum	15.43	40.41	47.36	72.78	30.59	19.93	31.65	37.31	33.46	43.99
Catharanthus .roseus L	7.20	23.52	27.03	34.73	16.96	10.35	14.69	17.16	25.62	23.12
oil concentration average	11.71	30.92	37.70	52.80		13.18	23.00	26.48	31.10	
LSD 0.05	plant	oil	Plant * oil			plant	oil	Plant * oil		
	3.06	3.54	6.13			4.91	5.67	9.82		

Table (5) effect of plant type and crude oil concentration on the total hydrocarbons concentration in root and vegetative groups of plants

The Table showed that the bilateral interaction between plant type and oil concentration had a significant effect, as *Cestrum nocturnum* plants treated with a concentration of 150 g kg gave the highest oil content of 72.78 µg gm-1 in the root system compared to the lowest content of hydrocarbons in the root system of *Catharanthus roseus* L. at a concentration of 0 g kg of crude oil reached 7.20 µg gm-1. In comparison, the concentration exceeded 100 gm kg in shoots of *Cestrum nocturnum* plants, reaching 37.31 µg gm-1.

Table (5) shows that the increase in the concentration of hydrocarbons in plant tissues with the increase in the concentration of crude oil in the soil is due to the ability of plants to absorb pollutants and accumulate them in their tissues (Ahammed *et al*., 2012). Plant species differ in their ability to absorb and accumulate pollutants in their tissues. Ibrahim *et al*. (2009) noted that the gene responsible for the coding GSH is responsible for increasing the plant's tolerance to polluting elements due to its ability to form chelates that facilitate the process of sequestering elements in succulent vacuoles. The process of pollutant absorption is affected by many factors, including temperature, where the efficiency of plants varies in absorbing In different seasons of the year, as it increases in the summer, as well as moisture, soil acidity, and salinity affect the process of absorption. Khairallah. Plants also differ in their accumulation of hydrocarbons and heavy elements, and this is due to the difference in the genetic makeup of the plant, and this agrees with Qasim when studying the effect of soil pollution with lead on some leafy green crops.

Total percentage of soil treatment of crude oil

Table (6) shows the effect of the type of plant and the concentration of crude oil on the percentage of the total treatment, as it gave the highest percentage of soil treatment of crude oil at a concentration of 50 g kg-1, as it reached 42.44 at the first measurement stage and 59.40 at the second measurement, compared to my treatment Crude oil at a concentration of 100 and 150 g kg. As for the average effect of the plant type, *Cestrum nocturnum* plants excelled in removing the highest percentage of hydrocarbons from the soil, reaching 40.78 in the first measurement period and 59.7 in the second measurement period, which did not differ significantly from *Tamarix aphylla*. At the same time, the lowest percentage of hydrocarbon removal from the soil of *Catharanthus roseus* L. for the two measurement periods was 22.33% and 32.3%, respectively.

Table (6) effect of plant type on the percentage of total treatment (removal) of crude oil from the soil

Plant type	**First stage**			**Average plant type Effect**	**Second stage**			**Average plant type Effect**
	oil concentration				**oil concentration**			
	50	100	150		50	100	150	
tamarix aphylla	47.33	34.33	33.97	38.44	77.5	69.20	54.70	67.2
Cestrum nocturnum	50.66	38.33	33.33	40.78	60.10	66.7	52.2	59.7
Catharanthus .roseus L	29.33	21.00	16.67	22.33	40.6	30.40	26.00	32.3
Average oil Effect	42.44	31.22	27.88		59.40	55.5	44.7	
LSD 0.05	plant	oil	interaction		plant	oil	interaction	
	2.71	2.71	4.69		7.53	7.43	12.87	

The interaction between plant type and oil concentration had a significant effect on the percentage of treatment, as *Cestrum nocturnum* plants treated with a concentration of 50 g.kg gave the highest treatment percentage of 50.66 at the first measurement stage, while in the second stage of measurement, the *Tamarix aphylla* plants excelled at a concentration of 50 g kg in gave the highest removal percentage, the removal percentage was 77.5, compared to the lowest treatment percentage produced from *Catharanthus roseus* L. plants, and the treatment with a concentration of 150 g kg of oil, and for the first and second measurement stages, as it reached 16.67 and 26.00, respectively.

It is noted from the results that the percentages of total oil remediation from the contaminated soil and the three plants are high. The reason is due to the ability of plants to absorb pollutants and their concentration in their tissues, which led to their decrease in the soil (Ahammed *et al*., 2012), or it is attributed to the role of compounds secreted by plant roots in stimulating Microorganisms in the soil and then the breakdown of hydrocarbon compounds (Liu *et al*., 2011; Cao *et al*., 2012). Experiments have shown that plant species differ in the degree of breakdown and removal of total petroleum hydrocarbons (TPHs) from oil soils (Al-Mansoory *et al*., 2015), and this is consistent with (Al-Tamimi, 2022).

Conclusions and recommendations

It is concluded that *Tamarix aphylla* L. and *Cestrum nocturnum* L. are superior in treating soils contaminated with crude oil. The three plant species can treat soils contaminated with crude oil, although they differ in their efficiency in removing pollutants from the soil. It was also concluded that different concentrations of crude oil negatively affect vegetative and physiological characteristics. aphylla in the treatment of soil contaminated with crude oil in the north of Basrah Governorate, a local plant that tolerates the climatic conditions of Basrah, has a large biomass and is highly efficient in removing pollutants.

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