Advances in Bioresearch
Adv. Biores., Vol 6 (3) May 2015: 144-148
©2015 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV 7.20 [Poland]

Advances in Bioresearch

ORIGINAL ARTICLE

Impact of Hydrocarbon Pollution of Sandy Soil on Growth of *Eucalyptus camaldulensis* Seedlings

Hassan H. Ali and Basim A. Abd Ali
Iraq Natural History Research Center and Museum, University of Baghdad, Baghdad, Iraq
Email: basimali2000@yahoo.com

ABSTRACT
Shelterbelts and plantations of Eucalyptus in Al-Najaf governorate might be subjected to pollution by crude oil and its derivatives because of establishing many oil projects in the region. The area is characterized by sandy soil and harsh summer temperature. While early stages of plant growth is of vital importance in plantation success, one - year old seedlings of eucalypt were subjected to three levels of oil pollution (25, 50, 100) liter per kilogram of sandy soil brought from the area of study. As the soil was high drained type, the effect of mixing the sandy soil with heavy one was tested, too. Deficiency of water might be expected under such circumstances; effect of water supply within two levels of irrigation to field capacity(1 day, and 3 days) was applied. Results showed reasonable tolerance of eucalypt to hydrocarbon pollution. Addition of 100 ml/kg resulted in decreasing the number of branches by about 30%, and stem diameter by 12%, while unexpectedly, 25 ml/kg of oil revealed in some improvement in growth parameters. Little depression in shoot length, number of branches, and stem diameter has resulted by elongation the interval of irrigation to 3 days. Sandy soil appeared inferiority to mixture type in all growth parameters. Mixing heavy soil with sand improved growth parameters by 3 to 30 percent depending on the property investigated. Pollution by 100 l/kg reduced dry weight of shoot and root by 21% and 28% respectively.
Keywords: *Hydrocarbon pollution, sandy soil, growth, Eucalyptus camaldulensis*

Received 10/02/2015 Accepted 29/04/2015

How to cite this article:
Hassan H. Ali and Basim A. Abd Ali . Impact of Hydrocarbon Pollution of Sandy Soil on Growth of *Eucalyptus camaldulensis* Seedlings. Adv. Biores., Vol 6 [3] May 2015: 144-148. DOI: 10.15515/abr.0976-4585.6.3.144148

INTRODUCTION

Eucalypt is well known as one of the fast growing trees, the reason made it an important genus throughout the world. Some studies reported that the global areas of eucalypt are about 18 Million hectare, and according to [1] it was expected that in 2010 the total areas will increase up to 20 Million hectare in the world. Although genus *Eucalypust* has more than 600 species and varieties, those cultivated due to the commercial standards, do not exceed a dozen of its kinds, *E. camaldulensis*is one of them [2].
Since the 50th of last century, species *camaldulensis* approved favorability to different Iraqi environmental conditions . It has been introduced and planted throughout the country except mountains where sever frost is dominant.
The area of Eucalypt plantations in the country was about 3000 hectare in 70th of last century. Since the date, new areas through forestation of unexploited areas were added each year. War conditions - during which petroleum fuel has frequently disappeared from local markets - forced people to use the wood of those plantations as alternative fuel. Such processes meant severe destroying to plantation projects. Conditions now are much better; planting by the species and other trees has extensively applied the last few years especially in middle and south of the country.
While Iraq is an oil producing country, the soil is subjected to pollution through the operations of production, refining, piping and transportation of crude oil and its derivatives. Crude oil is one of the pollutants that have significant impacts on soil and biological diversity it contains. Accumulation of heavy metals in many parts of plant could be result from pollution by oil derivatives. Ogbuehi and others [3] in their research on *Vigna unguiculata* grown in spent engine oil polluted soil found an accumulation of

heavy metals in leaves and seeds of plant which in turn cause cancer or mutation in humans due to biomagnifications in food chain.
Contaminated soil could be remediated by using some plants having the ability of reducing harmful effect. The technique that is called phytoremediation has been extensively investigated [4, 5, 6, 7]. The success of this technique depends on the extent of soil contamination, accessibility of contaminants for rhizosphere microorganisms, and the ability of the plant and microorganisms to intercept, absorb, accumulate, and/or degrade the contaminant [8]. Some contradictory results have been reported regarding the efficiency and performance of this technology in removing contaminants from soil [9].
The adverse effect of crude oil on growth was studied in preceding work [10]; it was higher in sandy soil. Such soil is the dominant type in the area between Holy Najaf and Karbala city, in which intensive plantation projects are performed, especially the shelterbelt project. From other hand, many oil establishments and related activities are founded throughout the region. Therefore, the research is a part of studying many cultivated species of trees as a phytoremediation plants to certain type of soil subjected to this kind of pollution.

MATERIALS AND METHODS

One year old seedlings of *Eucalyptus camaldulensisis* were brought from private nursery to the experimental area of Natural History Research Center and Museum, University of Baghdad. They were chosen to be uniform in shape and size. Forty eight seedlings were replanted in bigger polyethylene containers (35 x 25) cm after removing the old ones. They were planted in such a way making the roots surrounded from all sides and bottom by sufficient amount of new soil. Twenty-four of the containers were filled by 10 kg of sandy soil brought from the area of Al Najaf - Karbala quarries. Other containers were filled by a mixture of two parts; first was from the same sandy soil, second was a clay soil taken from nearby University gardens. While deficiency of water is an expected factor through the area of plantations, water supply was included in the study. One liter of water was enough to reach field capacity; this amount was applied in irrigation once a day, and each 3 days. In addition to control, three levels of pollution by crude oil (25, 50, and 100 ml/kg soil) were investigated. Certain amount of oil was thoroughly mixed with soil according to treatment. Experiment was designed as factorial CRD with three factors; soil (2 levels), water supply (2 levels), and pollution (4 levels). Each of the 16 experimental units involved 3 replications. Results were statistically analyzed by Statistica [11] for ANOVA and using Duncan Multiple Range Test for differences between treatments.

RESULTS AND DISCUSSION

Growth of plants was faster in earlier stages and then slowed down in the direction of hot summer months (Fig. 1). Shoot length rapidly increased from May to June after which, little rate of increment in length has obtained . Very high levels of temperature during summer months in Iraq could act as a growth-retarding agent. Slight adverse effect to pollution has observed on growth parameters starting from level two (0.25 l/kg). This level produced highest length, stem diameter, and number of living branches (Fig. 1, 2), it was even beyond control values. The addition of small amount of oil might assisted in soil particle aggregation, and eventually in retaining more water in rhizosphere. The use of 30 ml/kg in another experiment has also improved growth of *Sesbania sesban* [12].

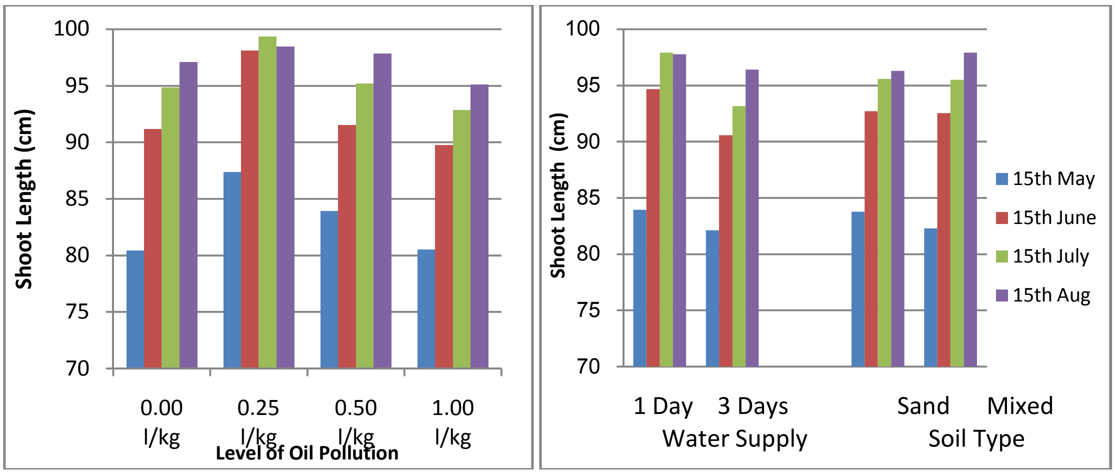

Figure 1: Plant- length progression with time as affected by oil pollution, water supply and soil type.

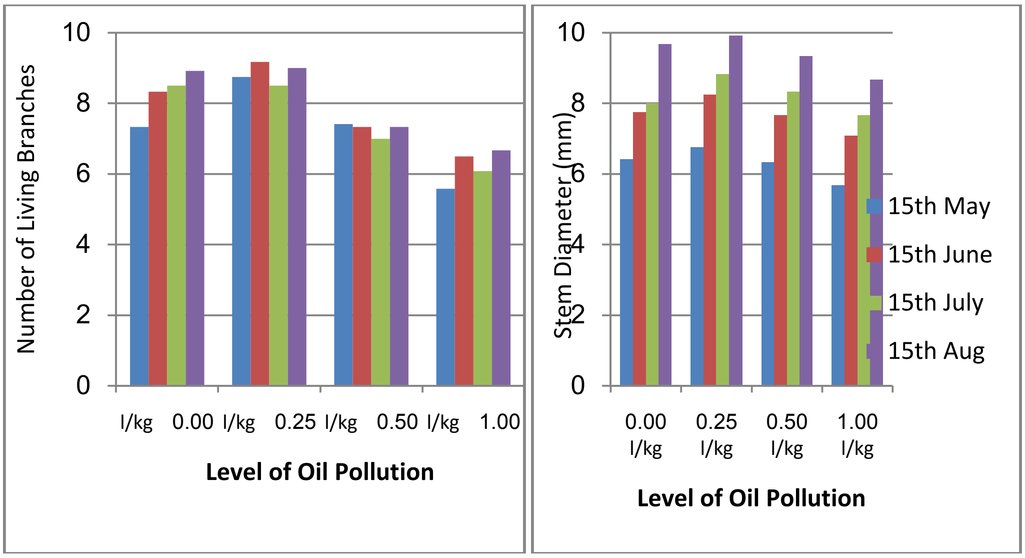

Figure 2: Effect of pollution by crude oil on number of living branches and stem diameter of *E. camaldulensis* seedlings.

Growth in diameter continued steadily with time for all levels of pollution. Once more, as what happened with length, level two (i.e. 25 ml/kg) gave higher rates of diameter, but highest quantity of oil resulted in more slim plants.

Table 1: Effect of oil pollution, water supply, and soil type on some dimensional properties of *Eucalyptus camaldulensis* seedlings.

Property	Factors		Oil Pollution*				Mean
			0.0 l/kg	0.25 l/kg	0.50 l/kg	1.00 l/kg	
Length of Plant (cm)	Water Supply**	1 day	98.33	98.00	94.67	100.00	97.75 (a)
		3 days	95.67	98.83	101.00	90.33	96.46 (a)
	Soil Type**	Sand	98.83	99.33	91.83	95.33	96.33 (a)
		Mixed	95.17	97.50	103.83	95.00	97.88 (a)
	Mean		97.00 (a)	98.42 (a)	97.83 (a)	95.17 (a)	97.11
Number of Branches	Water Supply**	1 day	10.00	8.17	7.83	7.34	8.33 (a)
		3 days	7.83	9.83	5.50	7.33	7.63 (a)
	Soil Type**	Sand	7.01	9.00	5.83	802	7.46 (a)
		Mixed	10.83	9.00	7.51	6.67	8.50 (a)
	Mean		8.92 (a)	9.00 (a)	6.67 (b)	7.33 (ab)	7.98
Stem Diameter (mm)	Water Supply**	1 day	9.67	9.66	9.50	7.67	9.13 (a)
		3 days	9.00	9.50	8.33	8.67	8.88 (a)
	Soil Type**	Sand	8.97	9.76	8.11	8.12	8.74 (a)
		Mixed	9.73	9.39	9.74	8.22	9.27 (a)
	Mean		9.33 (a)	9.58 (a)	8.92 (ab)	8.17 (b)	9.00
Root Length (cm)	Water Supply**	1 day	44.33	36.67	45.33	36.33	40.69 (a)
		3 days	47.17	45.17	37.67	48.67	44.67 (a)
	Soil Type**	Sand	44.17	38.91	36.71	42.97	40.70 (a)
		Mixed	47.36	42.94	46.10	41.99	44.59 (a)
	Mean		45.75 (a)	40.92 (a)	41.50 (a)	42.50 (a)	42.67

Mean values under specific factor having same letter are not different statistically at $p \geq 0.05$.
* Each value is an average of 12 measurements.** Each value is an average of 24 measurements.

Similar results was obtained with living branches, addition of 25 ml/kg oil encouraged more branching while maximum oil quantity dropped off the number of branches by about one third. Such reverse effect to high level of oil pollution on number of branches was found on *Conocarpus lancifolius* [10].

Growth parameters at the end of experiment showed more clear results. Shoot and root length had a weaker response to pollution than number of branches and stem diameter (Tab. 1). The effect of pollution seemed to be higher on shoot length when water deficiency increased. Maximum polluted plants were shortened by about 10% because of water deficiency. Comparing with control, this level of pollution dropped the number of branches off by about 18%, and stem diameter by 12%. First two pollution levels presented no statistical differences with control except in number of branches. The weak response of eucalypt seedlings to presence of mild amounts of oil in the soil could indicate that the species is well tolerant to this type of pollution.

Although differences were not at statistical levels, the effect of water supply appeared analogous to normal. Small depression in shoot length, number of branches, and stem diameter has resulted by elongation the interval of irrigation to three days. Under same
Environmental conditions of Baghdad city, growth of *Conocarpus lancifolius* showed higher dependence on water supply upon even water salinity [13]. Root showed quite different result through its elongation by about 4 cm because of the same reason. It is well known that water deficiency encourages root in more elongation to maintain an adequate plant water supply, and is under genetic control [14, 15]. Sharp and others, [16] illustrated that the root system response to soil drying is the ability of some roots to continue elongation. Soil type affected in such a way that mixed one produced slight higher growth parameters.

Weight related properties (Tab. 2) confirmed what was founded earlier about the first level of pollution. Plants polluted by 0.25 l/kg weighed more either for shoot or for root. The treatment produced 27% more shoot and 23% more root green weight than average. Treatment combinations showed that highest level of pollution was more effective on shoot weight at lowest water supply and at mixed soil. The same treatment combination produced quite heavier roots than plants daily irrigated. Mixed soil assisted in obtaining higher weights. As average, green and dry weights of plants grown in mixed soil had 16 – 30% more weight that means the presence of clay in mixture offered better growth conditions. Atwell and others [17] declared that in clay soils, soil particles and channels are small, and much of the water is effectively held by matric forces, and they are able to store large amounts of water. Also, clay soils offer more nutrients to plant, NCDA & CS Agronomic Division [18] explained that clay has at least 1000 times more external negative charges surface area than coarse sand, these surfaces can attract and hold

Table 2: Effect of oil pollution, water supply and soil type on weight of *Eucalyptus Camaldulensis* seedlings.

Property	Factors		Oil Pollution*				Mean
			0.0 l/kg	0.25 l/kg	0.50 l/kg	1.00 l/kg	
Shoot Green Weight (gm)	Water Supply**	1 day	29.67	47.17	30.83	33.33	35.25 (a)
		3 days	26.67	33.33	35.83	16.00	27.96 (a)
	Soil Type**	Sand	21.92	49.01	28.45	17.42	29.20 (a)
		Mixed	34.42	31.49	38.19	31.92	34.01 (a)
	Mean		28.17 (ab)	40.25 (a)	33.33 (ab)	24.67 (b)	31.61
Shoot Dry Weight (gm)	Water Supply	1 day	24.50	23.17	21.67	15.33	21.17 (ab)
		3 days	20.00	24.33	18.33	20.00	20.67 (ab)
	Soil Type	Sand	18.42	25.34	17.08	14.50	18.83 (b)
		Mixed	26.09	22.17	22.92	20.83	23.04 (a)
	Mean		22.25 (ab)	23.75 (a)	20.00 (ab)	17.67 (b)	20.92
Root Green Weight (gm)	Water Supply	1 day	62.33	64.83	50.17	31.83	52.29 (ab)
		3 days	48.83	62.83	52.50	41.00	51.29(ab)
	Soil Type	Sand	41.25	73.91	38.92	21.41	43.87 (b)
		Mixed	69.92	53.75	63.75	51.42	59.71 (a)
	Mean		55.58 (ab)	63.83 (a)	51.33 (ab)	36.42 (b)	51.79
Root Dry Weight (gm)	Water Supply	1 day	29.83	26.67	30.67	16.83	26.00 (a)
		3 days	20.83	24.67	28.17	19.67	23.33 (a)
	Soil Type	Sand	27.67	23.00	26.67	22.67	25.00 (a)
		Mixed	22.99	28.32	32.17	13.83	24.33 (a)
	Mean		25.33 (a)	25.66 (a)	29.42 (a)	18.25 (b)	24.66

Mean values under specific factor having same letter are not different statistically at $p \geq 0.05$.
* Each value is an average of 12 measurements. ** Each value is an average of 24 measurements.

Positively charged ions of plant nutrients, such as calcium, magnesium and potassium. Therefore, presence of clay in a mixture with sand made the soil more reliable and resistant to water deficiency.

CONCLUSIONS

From the above-mentioned results, following points could be concluding:

- Species *E. camaldulensis*is is well tolerant plant to oil type of pollution.
- Length of plant depends more on water supply than on level of oil pollution.
- Presence of small oil quantity in sandy soil improves growth parameters, but increasing the quantity could result in reverse influence.
- The addition of 100 ml oil/kg soil reduces all parameters significantly, especially that related to weight of plant.
- Mixed soil gives better resistance to pollution and water deficiency than sandy one.

REFERENCES

1. Iglesias, T.G. & Wilstermann, D. (2008). *Eucalyptus universalis*. Global cultivated eucalypt forests map 2008. *In*: GIT Forestry Consultant's EUCALYPTOLOGICS. Retrieved from http://git –forestry.com. Accessed 2014.
2. Acosta M.S., Marco, M. , Piter, J. C., Zitto, M. A., Villalba, D.I. & Carpineti, L. (2007). Physical and mechanical properties of *Eucalyptus grandis x E. tereticornis* hybrid grown in Argentina, IUFRO All Division 5 Conference, Taiwan.
3. Ogbuehi, H.C, Onuh, M.O & EzeibekweI, O. (2011). Effects of spent engine oil pollution on the nutrient composition and accumulation of heavy metal in cowpea [*Vigna unguiculata* (L.) Walp] Australian Jour. Agric. Engineering, 2(4):110-113.
4. Shirdam, R. , Daryabeigi Z. Ali, Nabibidhendi, G. & Mehrdadi, N. (2009). Removal of total petroleum hydrocarbons (TPHs) from oil-polluted soil in Iran. J. Chem. Eng. Research Note, Vol.28, No. 4, 105.
5. Al-Surrayai, A. , Yateem, R. , Al-Kandari, T. , Al-Sharrah & A. Bin-Haji. (2009). The use of *Conocarpus lancifolius t*rees for the remediation of oil-contaminated Soils. Jour. Soil and Sediment Contamination, 18(3):354-368.
6. Luepromchai, E., Lertthamrongsak,W., Pinphani-chakarn, P., Thaniyavarn, S., Pattaragulwanit, K. & Juntongjin, K. (2007). Biodegradation of PAHs in Petroleum-Contaminated Soil using Tamarind Leaves as Microbial Inoculums. Songklanakarin J. Sci. Technol. 29(2): 515-527
7. Tesar, M. , Reichenauer, T.G. & Sessitsch, A. (2002). Bacterial Rhizosphere Populations of Black Poplar and Herbal Plants to be used for Phytoremediation of Diesel Fuel. Soil Biology and Biochemistry, 34(12):1883-1892.
8. Vangronsveld, I., Herzig, R., Weyens, N. , Boulet, J., Adriaensen, K., Ruttens, A., Thewys, T., Vassilev, A., Meers, E., Nehnevajova, E., van der Lelie, D. & Mench, M. (2009). Phytoremediation of contaminated soils and ground water: lessons from the field. Environ Sci Pollut Res Int. 16(7):765-94.
9. Joner, E.J., Hirmann, D., Szolar, O.H.J., Todorovic,D., Leyval, C. & Loibner, A.P. (2004). Priming Effects on PAH Degradation and Ecotoxicity During Phytoremediation Experiment. Environ. Pollut.128:429-435.
10. Abd Ali, Basim A. & Hassan H. Ali, (2014). Possibility of Using *Conocarpus lancifolius* Engl. in Remediation of Some Iraqi Soils Polluted by Crude Oil. Adv. Biores. 5(1):185-190.
11. Statsoft Incorporated. (1997). Statistical ('99 Edition) Quick Reference. http://www.amazon.com. Retrieved from http://git –forestry.com. Accessed 2014.
12. Abd Ali, Basim A. & Hassan, H. Ali. (2013). Possibility of using *Sesbania sesban* for bioremediation of soil polluted by crude oil. 5th World Conference on Ecological Restoration. Madison, Wisconsin, USA.
13. Abd Ali, Basim A. Resistance of *Conocarpus lancifolius* Engl. To different levels of salinity and water supply. ARPN Jour. Agric. Bio. Sci. 9(6):211-215.
14. O'Tool, JC & Bland, WL. (1987). Genotype variation in crop plant root systems. Advances in Agronomy, 41, 91-145.
15. Sponchiado, BN., White, JW., Castillo, JA. & Jones, PG. (1989).Root growth of four common been cultivars in relation to drought tolerance in environments with contrasting soil type. Exp. Agric. 25, 249-257.
16. Sharp, R., Poroyko, V., Lindsey, G., Spollen, W., Springer, G., Bohnert, H., & Nguyen, H. (2004). Root growth maintenance during water deficits: physiology to functional genomics. J Exp Bot., 55(407)2343–2351.
17. Atwell B. J., Kriedemann, P.E., & Turnbull, C.G.N. (1999). Plants in action: adaptation in nature, performance in cultivation. McMillan Education Australia, South Yarra. pp. 664.
18. [18] NCDA & CS, Agronomic Division. (1999). Clay Minerals: Their Importance and Function in Soils. Soil Fertility Note 13, 2p. www.ncagr.gov/agronomy.

