Consequences of Soil Crude Oil Pollution on Some Wood Properties of Olive Trees

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Received in : 9/1/2012 , Accepted in : 19/5/2013

Abstract

To enlighten the extent of crude oil pollution effects on some anatomical characteristics of olive plant (*Olea europaea*). Two years - old seedlings were chosen to grow under 5 levels of pollution (0.0, 0.5, 1.0, 2.0, and 3.0, liter/ plant). The experiment has been conducted in the experimental field of Natural History Research Center and Museum, University of Baghdad. It was designed as CRD experiment. Testing wood specimens were prepared after 2.5 years of growth. Fiber length, width, wall thickness, and wood specific gravity were measured. Results showed that olive plants could not resist the highest level (3 liters / plant) of pollution .Fiber length was the most affected property by treatment. All fiber dimensions were decreased with the increase of pollution level. The reduction was unsystematic. 12% of the fiber length was reduced as a result of pollution. Wood specific gravity of polluted plants showed few higher values than that of control. Lower parts of stem seemed to be more affected, that may be because these parts are fare away from crown (the source of oxen).

Keywords: olive, wood, soil, pollution, properties, crude, oil.

Introduction

The continuous growth of environmental pollution and anthropological disturbances to ecosystem has made the study of abiotic stress responses in plant become increasingly more important in agriculture, forest management , and ecosystem restoration strategies (1). Crude oil pollution is perhaps the most publicly recognized as serious pollutant despite much of the world depends on the production, trade, or manufacturing of oil. Although oil hydrocarbons are common pollutants and their biodegradation is the subject of numerous studies, information on their toxicity to the plant in the soil is limited. The reaction of some plants after the contamination of ground and water with oil products was studied by Petukhov et.al.(2). They discussed the negative effects of oil contamination on seed germination, reduction of the total biomass and the length of the roots .

The presence of petroleum in the soil affects its diversity, canopy and productivity. Little is known about the chronic effect of oil pollution (3). Michel et. al. (4 , 5) stated that petroleum constitutes a pollutant that can persist in the environment for a long period until the vegetation recovers completely , and its persistence can be explained by the slow biodegradation of hydrocarbons .

According to Green et al . (6) , a variety of reports , patents and scientific papers have addressed the problems of fuel contamination in soil , including chemical characterization and treatment , bioremediation by bacteria metabolism and the impact on biological organisms in the contamination soil .

The poisoning mechanism and its dose – response are the biggest concern for toxicologists. The inhibition of germination and the reduction of plant growth as well as its death are indication of the toxicity of hydrocarbons (7) . The study of plant behavior in petroleum contamination soils allows the identification and selection of oil – pollution – indicating species . Petuchov et. al., (2) recommended that tested species could be used as test organisms in analyzing the toxicity of this pollutant in soil and water. Comparison of the *Podocarpus lambertii* trees exposed to petroleum with the control set , showed that the length , diameter and cell wall width of the tracheids of the polluted trees were smaller than that of control (8) .

Olive tree (*Olea europaea* Linn)was introduced to Iraq since a long time ago and extensively cultivated in different parts of Iraq (9) especially in the upper parts of the country. The tree is considered as a tolerant for drought , and for nitrogen deficiency (10). Recently , Iraqi Ministry of Agriculture considers the tree as one of the important economic plants and adopted many projects to expand planting areas and encouraged farmers for planting the tree in their private plantation . Although oil is the main product of olive tree, it is considered as a good source for high quality timbers .Wood is the result of a biological process and grows under a wide range of genetic and environmental influences. Environmental conditions play an important role in tree growth and wood characteristic . Though , any factor having an influence on one or more of these conditions could have an effect on the growth and wood properties . Thus the present study intends to focus on the effects of crude oil pollution on some of olive wood properties .

Materials and Methods

Olive seedlings nearly two years old were brought from local nursery in Baghdad and planted at experimental area of Natural History Research Center . Six months later, the uniform and nearly equal lengths seedling were chosen and exposed to five levels of crude oil pollution. The experiment was designed as a complete randomized experiment with 5 levels, and 4 replications. Amounts of pollution for each level were as follows ; 0, 0.5, 1.0, 2.0 and 3 liter of Basra light crude oil (obtained from Ministry of Oil) for L0 , L1, L 2 , L3

and L4 respectively .Accordingly, measured quantities of crude oil was poured around selected seedling . Then, uniform irrigation processes were applied to all experimental units . Plants were left to grow for a period of thirty months. After that, the developed shrubs were harvested from the ground .

Two disks from the main stem were cut, the first from the base , the second from the uppermost where it was possible to obtain a disc with sufficient diameter. Each disc was divided into two equal parts, one of them was further divided into small sticks for maceration, the other was used for preparing samples of specific gravity. Maceration has done according to (11). 40 readings were taken for any of fiber length, fiber diameter, lumen diameter and wall thickness for each level of experimental combinations. Specific gravity was measured for the upper and lower parts of stem separately, and it was determined by immersion method where each mean value represented a mean of 4 measurements.

The experiment was designed and conduced by using complete randomized design (C.R.D) , and the treatments were replicated four times . The results were statistically analyzed by using Statistica program (99 Edition) .

Results and discussion

The experiment showed that olive plants of two years old could not survive after pollution by the highest level L4 (3 liters / plant), therefore they were excluded from statistical analysis, and the levels of pollution became 4 (L0, L1, L2, and L3) only. Fiber length was the only property of fiber dimensions that significantly affected ($p<o.o1$) by crude oil pollution (Table 1) . Fiber diameter and wall thickness did not appear significant differences that might be because of their small values, accordingly changes would be smaller.

All fiber dimensions generally decreased as a result of oil addition . Mean value of the three treated levels (0.710 mm) showed a reduction in fiber length of about 12% as compared to control (Table 2). L1, unexpectedly, gave the lowest length. Micro - environmental conditions under which a specific plant grows could be a reason. Although fiber diameter and wall thickness did not show statistical response to pollution, it was an evidence that some reduction has been occurred in both properties with the addition of oil. Similar results were obtained by Maranho et.al., 2009 when exposed *Podocarpus labertii* trees to petroleum. The inhibition or reduction of plant growth as well as its death were regarded as indication of hydrocarbons toxicity (Powell, 1997). An interest result could be observed, that's the treatment having shortest fibers (L1) showed the highest values of diameter and wall thickness.

Specific gravity was affected by pollution levels (Table3). Results of significances showed that most of effects were obtained at lower parts of stem ($p<0.01$), while upper parts did not affect significantly.

It is known that there is a direct relation between specific gravity and both of fiber diameter and wall thickness. Narrower fibers give higher density when they have approximate equal wall thicknesses . This fact could be observed when comparing results of table 4 with that of table 2 especially for L2 treatment. In general specific gravity of treated plants had some higher values than that of control. It seems that one liter / plant is the level at which fiber diameter and lumen were severely affected. This effect led to have higher specific gravity for the same levels.

Wood of higher specific gravity corresponded to specific level of pollution could be explained by inhibition or retarding effect of oxen's which accelerate division of cells with a wider cavities. Similar explanations could explain why the lower wood was more significant, when we know that upper wood is nearer than lower one to the crown (the source of oxen).

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Table No. (1): Analysis of variance of crude oil pollution effects on olive wood properties .

Wood Property	df effect	MS Effect	df error	MS error	F
Fiber length	3	202.08	8	27.33	7.393**
Fiber diameter	3	3.14	8	1.15	2.712
Wall thickness	3	0.0422	8	0.0316	1.333

* significant at p< 0.05 , ** at p < 0.01.

Table No.(2): Means of fiber dimensions as affected by different levels of crude oil pollution

Level of Pollution liter / plant	Wood Properties			
	Fiber Length (µm)	Fiber Diameter (µm)	Lumen Diameter (µm)	Wall Thickness (µm)
L0 (0.0)	813.3	15.60	10.94	2.33
L1 (0.5)	620.0	15.70	10.36	2.67
L2 (1.0)	750.0	14.30	10.10	2.10
L3 (2.0)	760.0	14.97	10.77	2.10

Note: Each value represents mean of 40 measurements.

Table No.(3): Analysis of variance (ANOVA) of crude oil pollution effects on olive wood specific gravity.

Specific gravity	df effect	MS effect	df error	MS Error	F
Upper	3	1331.68	8	526.06	2.531
Lower	3	2271.35	8	319.89	7.100**
Mean	3	1718.75	8	337.83	5.087*

* significant at p< 0.05 , ** at p < 0.01.

Table No.(4) : Mean values of olive wood specific gravity as affected by different leves of oil pollution.

Level of pollution (liter / plant)	Specific Gravity		
	Lower	Upper	Mean
L0 (0.0)	594.7	571.0	583.0
L1 (0.5)	591.0	570.0	580.7
L2 (1.0)	611.5	598.5	605.0
L3 (2.0)	601.2	584.3	592.9

تأثيرات تلويث التربة بالنفط الخام في بعض صفات خشب الزيتون

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استلم البحث في : 2012/1/9 ، قبل البحث في : 2013/5/19

الخلاصة

لتسليط الضوء على مدى تأثير التلوث النفطي في بعض الصفات التشريحية لخشب الزيتون أجريت التجربة في الحقل التجريبي لمركز بحوث ومتحف التاريخ الطبيعي، جامعة بغداد. أختيرت شتلات بعمر سنتين وزرعت بتأريخ 15 شباط 2009. عرضت إلى خمسة مستويات من التلوث (0,0 ، 0,5 ، 1,0 ، 2,0 ، 3,0) لتر / شتلة. تركت الشتلات للنمو مدة سنتين ونصف السنة تحت تأثير التلوث. تمت دراسة التأثير في كل من: طول الليف ، وقطر الليف ، وقطر التجويف ، وسمك الجدار، والوزن النوعي للخشب. حللت النتائج على وفق التصميم العشوائي الكامل (5 مستويات ، 4 مكررات). ظهر من النتائج ان شتلات الزيتون لم تتمكن من مقاومة المستوى الاعلى (3 لتر/شتلة) للتلوث مما أدى إلى هلاكها خلال الموسم الأول.

تناقصت أبعاد الألياف (الطول ، القطر ، وسمك الجدار) مع زيادة التلوث على الرغم من أن التناقص لم يكن منتظما وقد كان طول الليف أكثرها تأثرا فقد قل طول الليف بمعدل 12% نتيجة لاضافة النفط الخام . الوزن النوعي للخشب اظهر زيادة طفيفة للمعاملات المعرضة للتلوث ولا سيما في الأجزاء السفلية من الساق الأكثر بعدا عن التاج (المصدر المجهز بالأوكسينات).

الكلمات المفتاحية : الزيتون، خشب، تلوث، التربة، نفط خام.