The Impact of Ascending Levels of Crude Oil Pollution on Growth of Olive *(Olea europaea* Linn) Seedlings

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Abstract

A study on the impact of ascending levels of crude oil on the growth of transplanted seedlings (March2005) of Olive (*Olea europaea* Linn) was carried out at the experimental area of Iraq Natural History Museum and Research centre / Baghdad University (Bab-Al-Madham –Baghdad) grown under field condition and continued till April 2008.The experiment was laid out in complete randomized design (CRD) with five levels of pollution (0.0 , 0.5 , 1.0 , 2.0 and 3.0 liter / seedling) poured at the soil surface , each seedling represented one replicate and was replicated four times . Data collected from the experiment were visual symptoms , percents of seedlings death, plant height and total dry weight of harvested plants. The results indicated that crude oil pollution caused an adverse effect on the Olive (*Olea europaea* Linn). The crude oil led to leaf chlorosis , dryness and death of seedlings. The adverse effects were proportional with the levels of pollution. Plant heights and total dry weights were significantly reduced ($p < 0.05$) as a consequence of pollution. Results of the study indicated that the effect of pollution clearly appeared after three weeks at the high levels then the symptoms extended to lower levels during the first six months. The study showed that treated plants with low levels of crude oil pollution were less growth but survived and stayed alive, while the higher levels led to seedlings death. It was obvious that the adversely affected plants could not be able to recover even after 27 months after pollution, the time of the experiment.

Introduction

Olive tree *(Olea europaea* Linn) , is a small tree , mostly not exceeding 6 t0 9 m in height , and bearing small lanceolate leaves and axillaries flowers oblong. While the production of oil is the main aim of planting this species ; a specific orchard management should be applied to maintain acceptable levels of productivity, oil quality, and cost of production (1).

It was introduced to Iraq since a long time ago and extensively cultivated in different parts of Iraq(2) especially in the upper parts of the country. The tree is considered as tolerant for drought, and for nitrogen deficiency (3).Recently the 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 to grow the tree in their private plantations.

Soil protection and remediation of oil polluted soil sites became an important part of the environmental protection policy in many oil producing countries. Research in preventing and recuperating oil pollution became an integral part of petroleum industry activities because the crude oil has considered as the most lasting and persistent environmental pollutants affecting the soil ecosystems.

Crude oil pollution is the most frequent one in Iraq than in any other producing countries due to the wars , fighting and unnatural security conditions , where pipe lines , oil transporting trailers and tanks were mostly exposed to attack by explosions causing an intensive crude oil - soil pollution .

Plants respond differently to pollution depending on many factors such as type and level of pollutant , age and size of the plant and Its inherent characteristic, in addition to environmental conditions under which the plant is grown.   Oil pollution has adversely effects on different plant species (4) ,(5) , (6) and (7) referred to crude oil as phytotoxic for many plants and considered the poor growth of oil treated plants as attributed to suffocation of plants caused by exclusion of air by the oil or exhaustion of oxygen by the increased microbial activity and toxicity from some oil compounds .

In spite of the adverse effects of oil pollution on the plants, no much works were done in Iraq and due to the shortage of the available literatures related to this subject current study had been done and aimed to investigate the performance of   Olive tree (*Olea europaea*) growth under different levels of crude oil pollution .

Materials and Methods

Fifty   seedlings of Olive (*Olea europaea*)   nearly 30-40 cm tall   and free of insects or dieses infections obtained from a local nursery and were transplanted in a clay soil with distances of one by one meter between seedlings at the experimental area of the Iraq Natural History Research Centre & Museum / Baghdad University on May of 2005 . Twenty healthy seedlings and nearly equally height of them were selected on December 2005 . Five levels of Basrah light crude oil obtained from Iraqi Oil Ministry used (0.0 (L0) , 0.5 (L1), 1.0 (L2) , 2.0 (L3) and 3.0 (L4) liter of oil / seedlings) were distributed randomly on the selected seedlings and each level was repeated four times .Soil Crude oil pollution was simulated by pouring the crude oil over the surface soil and inorder to ensure that the amounts in all treatment were distributed over the same area, a ring of a plastic tube with diameter of 30 cm was made , and was put on the soil to surround the seedling, then the crude oil was distributed equally and evenly inside the ring. Resulted trees were harvested on April 2008. The impact of the seedling as affected by crude oil was studied depending on the visual symptoms   and observations appeared on the plants, percents of death seedlings(percent of death seedling to the 4 replications of each treatment) were   collected during the experiment time and on the measurements of the heights and total dry weight of harvested trees. Complete randomized design (CRD) was used as an experimental design and the results were were statistically analyzed by using Statistica program (99 edition)(8).

Results and Discussion

The treated surface soils were turned immediately to oily with brown color after adding the crude oil. The resulted color was proportional with oil level used. The surface soil of L1 , L2 and L3 was able to absorb the crude oil amounts directly after the addition , while soil of L4 took more time to absorb and became saturated with it. The intensity of the brown color of the surface soils started to the reduce gradually with in time and this could be due to the degradation of the oil or the penetration within the soil. The treated surface soils were able to recover to the original color during the first six months of the experiment . The consumed time to recover the original soil color was also proportional with the levels of crude oil used .

All the   seedlings of   Olea europaea   exposed to crude oil responded negatively   to pollution   in comparison with control treatment (L0) Fig (1). Chlorosis (yellowing of plant leaves) was the early distinguished symptoms observed on all of the crude oil treated seedlings . Although the chlorosis was a common   feature for all of the treate seedlings, their yellow color intensity was different and ranging between light to intensive depending on levels of pollution being used . The chlorosis was firstly observed in some of the old leaves and then developed with in time to speared all over the plant and eventually led to the dryness and death of seedlings in some cases especially in the higher levels of pollution (L3 and

L4). In spite of no obvious cases of infection were observed during the time of the experiment, it was possible to ensure that the dryness and death followed the chlorosis were due to pollution and not for other reasons and therefore, put the dead seedlings under a close visual and microscopic examination   .   First case of seedling dryness and death was recorded on L4 treatment after three weeks, and then the phenomena appeared on other treatments within the first six months after pollution. Crude oil pollution caused death to some replications of the treated seedlings and the percent of death was directly proportional to the level of pollution and ranged between 75 to 100 % Fig(2). The increase of the death percentage of *Olea europaea* with the increase of the levels of crude oil pollution was clearly indicated to an adverse effect of oil on this species. It is well known that the visible symptoms have often provided the first indication of other problems which might be resulted from the impaired metabolism within the plant. Crude oil pollution led to different symptoms on seedling during the first six months after exposing to crude oil. Old leaves of treated seedling became pale in comparison to control and this could be due to the breakdown in chlorophyll production. Such symptom had similar aspects of nitrogen deficiency, where specific symptoms of nitrogen deficiency first appear on the oldest leaves. Plant suffering from nitrogen deficiency is pale in color in comparison to healthy one due to the breakdown in chlorophyll production. Such observations were noticed by (9) where they referred that the specific symptoms of nitrogen deficiency first appeared (as with deficiencies of phosphorus and potassium) on the oldest leaves, and these become paler then turned to chlorosis (Marked yellowing) . It is well known that crude oil pollution leads to increase soil organic carbon as well as the populations of total heterotrophic microorganisms and also, a reduction in nitrate-nitrogen and available phosphorus (10).The shortage of nutrients availability ,especially the nitrogen as a result of the increase of the total soil heterotrophic could be expected according to the current study since no nitrogen fertilizer was added. For this reason, the nitrogen deficiency could be as one cause of the chlorosis and can not be rolled out.

The adverse effects of crude on *Olea europaea* trees continued for more than 27 months after pollution . No more death happened for trees after the first six months but the survived trees from crude oil pollution possessed weaker growth in comparison with control as reflected by trees height and total dry weight .The mean height for control trees was 203.7 cm   , but due to pollution it was reduced to 79.5 , 36.5 , 14.7 , 0.0 cm   for L1, L2, L3 and L4 respectively table (1). Total dry weigh also was reduced from 675.5 to 195.87, 30.62 , 12.25 ,   0.0 gm for the same three levels Table (2). Current results clearly refer to the adverse effects of crude oil on plants growth and were in an agreement with to the results of (4),(5),(7), (11), (12), and (13) . Since uptake of water and nutrients is carried out by the root system, untreated seedlings of *Olea europaea* with sound, healthy roots grew normally while the treated seedlings could suffer from anatomical aberration that may caused by presence of oil films in a specific parts of plant leading to a negative effect on the growth. In anatomical study (14) noticed the presence of oil films in the epidermal and cortical regions of root, stem and leaves of the plant .

The increase of death percent of *Olea europaea* seedlings with increasing of pollution as occurred in the current study, could be due to one or a combination of following factors; disruption of root-soil-water relationship , direct impact on plant metabolic processes , toxicity of living cells, reduced oxygen exchange between the atmosphere and soil , nutrients immobilization and an alteration in the physical, chemical and biological properties of soil. Such factors could have observed visual symptoms , reduction in biomass or deaths of seedlings. From the foregoing, it is clear that crude oil may affect plant by causing direct death due to coating the roots and soil particles by it or through the affect of toxic components, where the oil or its components interfere with cellular processes, resulting the plant death .

Conclusion

Some conclusions could be mentioned according to this experiment ; (a): Crude oil application to soil

has adverse effects on the growth of *Olea europaea* seedlings ,(b): The effect being proportional to the concentration of crude oil is applied, (c): Oil may affect the plants by causing direct death in high levels of pollution , (d): In some levels of pollution olive plants may undergo a weakness in growth and reduction of biomass producing a stunted plants, and (e) the effect of pollution by crude oil on *Olea europaea* may last more than 27 months (the period of the experiment).

Acknowledgements

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Table (1):   Plant height (cm) at the end of the experiment as influenced by five levels of crude oil

Treatments	Plant Height (cm) Replications				
Levels of soil pollution	1St	2nd	3d	4th	Mean
L0	209 .0	228.0	192.0	186.0	203.7a
L1	152.0	166.0	0.0	0.0	79.5 b
L2	0.0	94.0	52.0	0.0	36.5 b
L3	0.0	0.0	0.0	59.0	14.7 b
L4	0.0	0.0	0.0	0.0	0.0 b

0.0 refer to dead plant. Means with different superscripts are significantly different (LSD) at $p < 0$

Table(2):   Plant dry weight (gm) at the end of the experiment as influenced by Five levels of crude oil in soil

Treatments (Levels of soil pollution)	Dry Weight (gm) Replications				
	1St	2nd	3d	4th	Mean
L0	735.0	980	686	661	675.5 a
L1	367.0	416.5	0.0	0.0	195.87 b
L2	0.00	61.25	61.25	0.0	30.62 b
L3	0.00	0.00	0.00	49.0	12.25 b
L4	0.00	0.00	0.00	0.00	0.00 b

0.0 refer to dead plant . Means with different superscripts are significantly different (LSD) at $p < 0.05$

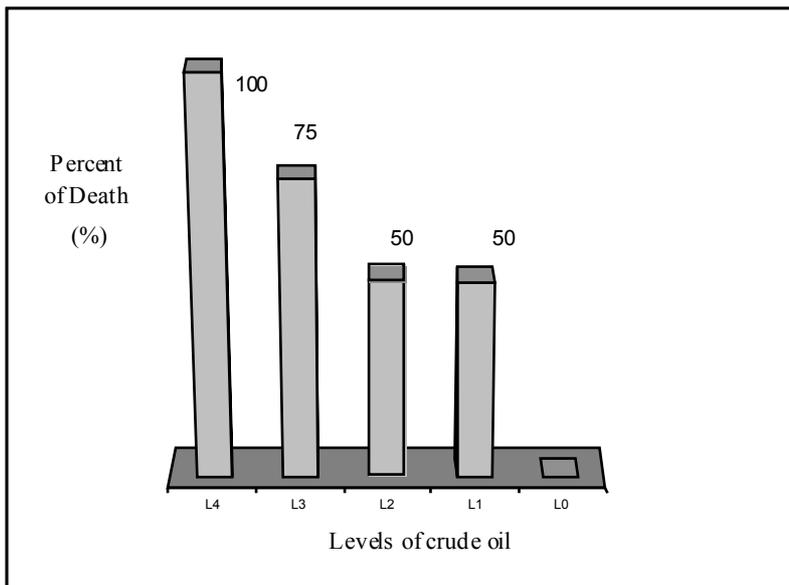**Fig (1): Effect of five levels of crude oil on the growth of Olive seedling after six month from pollution**

Fig (2):   Effect of five levels of crude oil pollution on the percent of death of olive plan

تأثير مستويات متزايدة من التلوث بالنفط الخام في نمو شتلات *Olea europaea* الزيتون

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الخلاصة

درس تأثير مستويات مختلفة من النفط الخام في نمو شتلات الزيتون المزروعة في اذار 2005 في المساحة التجريبية في مركز بحوث و متحف التاريخ الطبيعي /جامعة بغداد (باب المعظم – بغداد) تحت الظروف الحقلية المدة من آذار 2005الى نيسان 2008 . صممت التجربة الحقلية على التصميم العشوائي الكامل باستخدام خمسة مستويات من النفط الخام وهي (0.0 ، 0.5 ،1.0 ، 2.0 و 3.0 لتر نفط / الشتلة) اضيفت على سطح التربة و باستعمال أربعة مكررات، اذ كل شتلة مثلت مكرر . البيانات التي جمعت من التجربة شملت تسجيل الأعراض المرئية التي ظهرت على النباتات، و النسبة المئوية لموت النباتات، و أطوال النباتات، و الوزن الجاف الكلي للنباتات بعد الحصاد. أشارت النتائج إلى أن التلوث النفطي أدى إلى ظهور آثار سلبية على نباتات الزيتون تتناسبت مع مستويات التلوث. أدى التلوث النفطي إلى ظهور أعراض الاصفرار على الأوراق و الجفاف ثم موت النبات احيانا .انخفضت أطوال النباتات و أوزانها الجافة احصائيا على مستوى احتمال 0.05 نتيجة للتلوث النفطي. اشارت نتائج الدراسة الى ان اثر التلوث ظهر واضحا بعد ثلاثة اسابيع في المستوى الاعلى من التلوث ثم بعدها امتد ظهور الاعراض الى المستويات الادنى وذلك خلال الاشهر الستة الاولى. كما أظهرت نتائج البحث ان النباتات المعاملة بالمستويات القليلة من النفط الخام كانت اقل نمواً و لكنها استطاعت ان تنجو و تبقى حية في حين ادى التلوث بالمستويات العالية الى موت الشتلات. وقد كان واضحا ان النباتات التي تأثرت سلبيا بالتلوث استمر معها التأثير السلبي ولم تتعاف حتى بعد مرور 27 شهرا من بدء التلوث النفطي ، مدة استمرار التجربة.