

Effect of Soil Polluted with Crude Oil on Some Wood Properties of *Casuarina equisetifolia*

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Abstract

The current experiment was conducted to explore the effect of soil crude oil (crude oil) pollution on some wood properties of *Casuarina equisetifolia*. Four levels of pollution were applied on 40 (one-year) old seedlings . Measurements were taken by cutting the trees after two growth seasons from date of pollution .The studied Properties were fiber length, diameter, wall thickness, and specific gravity of external and internal wood. Results showed an adverse effect of pollution on fiber diameter more than on fiber length. While wall thickness did not affect. Fiber dimensions of external wood showed higher values than that of internal one, especially for fiber length. Specific gravity was affected by pollution and its interaction. A significant increase in specific gravity was observed with higher pollution levels for external wood only i.e. for the two layers formed after pollution.

Introduction

Casuarina equisetifolia, is a species belonging to the family *Casuarinaceae* which has been divided into four genera, viz: *Casuarina*, *Allocasuarina*, *Gymnostoma*, *Ceuthostoma* [1] . The genus *Casuarina* contains about 70 species native to the old world tropics [2]. It has the ability to grow on poor sites by enhancing their capacity to form symbiotic root nodules which are capable of fixing atmospheric nitrogen. The nodules contain Actinomycete bacteria thought to belong to the genus *Frankia* [3]. The same author mentioned that Casuarinas are also known to develop proteoid roots and extensive mycorrhizal associations which probably assist in their nutrition. Egyptians planted the trees along the coast to protect houses from the wind and salt spray [4].

C. equisetifolia is tall evergreen tree. It can reach heights of over 30 m. The branches often drooping sulcate, green, with 6–8 scalelike leaves. Internodes 5–7.5 mm long on the branchlets, only 2.5 mm on main shoots. Main shoots minutely hairy, with small recurved scales about 2.5 mm long, usually 8 in a whorl [4]. They are extremely accepting of salt spray and poor beach soils. Its nut-let fruits ½ in. in diameter embody winged seeds.. Common names are ironwood, beefwood, she oak, and horsetail tree [5] .

The wood of *Casuarina* is dense and very hard, , splits easily , and burns slowly with little smoke or ash. It makes an excellent fuel, used particularly in India and China, producing good heat and being relatively smokeless when burnt . *C. equisetifolia* is reputed to be the best fuel wood species in the world. The appearance of the wood, caused by dark-colored, wide medullary rays, makes it attractive for wood turning and parquetry. The timber is also used for pulp in Philippines and Okinawa, and it is widely grown as a windbreak in southern coastal China and also around citrus groves in Florida [3].

It is well known that soil pollution interrupts physiological processes carried out by plant. The different kinds and levels of pollution could result in different effects on the plant. On the other hand, different plant species don't have similar responses to pollution. Crude oil pollution have adverse effects on soil fertility and plants production through altering physiological processes and anatomical structures of cells and tissues. Some researchers worked in this field and reported that crude oil spillage on soil makes it unsatisfactory for plant growth [6 , 7]

Iraq as an oil producer country, its soil often exposes to crude oil pollution during oil production, refining, and transportation. *C. equisetifolia*, as a predominant cultivated species throughout the country and because the foregoing properties of the tree and its wood, it was chosen to be tested under the influence of crude oil pollution. In a previous research, the effect of pollution on the plant growth was studied [8]. During this experiment, wood element properties and specific gravity were selected as a studied factors, since no much works were done in this direction.

Materitls and Methods

The experiment was conducted in the experimental area and plant laboratory of Iraq Natural History Research Centre & Museum, Baghdad University, Bab-Almuadham campus, Baghdad. Forty (one-year old) equally length seedling of *Casuarina equisetifolia* were planted in the field on 5th of March 2005 in three rows with a distances of one by one meter in clay soil. Planting process was done in the way that the roots of plants had an equal depth from ground surface to assure regularity of treatments. The seedlings were left to grow normally in the field till 4th of December 2005. Then twenty equally length seedlings were selected to be the units of the experiment. Five levels of crude oil (Basra light crude oil) used ((L0) 0.0, (L1) 0.5, (L2) 1.0, (L3) 2.0 and (L4) 3.0) liter / seedling were added to the soil surface surrounding the plant within a circle of 30 cm diameter. The experiment was conducted by using complete randomized design (C.R.D), the treatments were replicated four times. On the end of December 2007 the experiment was ended by cutting the plants and the effects of crude oil pollution on wood fiber length, diameter, wall thickness and specific gravity of *Casuarina equisetifolia* were evaluated. Three (1 inch) discs were prepared by cross cutting the stem from lower, middle, and upper part. Each disc was divided radially into two equal parts to assure obtaining of external and internal wood specimens according to their distance from the pith. Small three samples were prepared from each position for testing specific gravity and three others for maceration, these last three were further divided in to small sticks, mixed and a sufficient amount was taken for maceration. Fibers were macerated by glacial acetic acid and hydrogen peroxide. Plants of L4 i.e. 3.0 liter / plant could not survive to the end of experiment, hence they were excluded.

Measurements of fiber dimensions were applied on 20 elements for each replicate, i.e. mean value of each level of treatments was represented by 80 measurements. The results obtained were analyzed by using [9].

Results and Discussion

Fiber dimensions responded differently to the level of pollution and to specimen position factors and their interaction. Fiber diameter seemed to be the most affected one while wall thickness had no response neither to pollution nor to the position of the specimen (Table 1). Specific gravity was affected by the pollution factor and its interaction with specimen position.

Fiber length of wood layers near the bark was much higher than that of layers near the pith (Table 2). The increment was about 18%. The same trend of effect was observed with fiber diameter but lesser than occurred with the fiber length. Similar results were obtained with other tree species [10]. Literature assured such trend of increment especially in juvenile wood [11, 12]. The effect of pollution on fiber length was not obvious on internal wood, while in case of external wood shorter fibers (except L3) were obtained with higher pollution levels. Also, fibers were narrower with increasing pollution regardless to wood position i.e. the decrement in diameter was not limited to the external wood as happened with fiber length. External wood showed thicker fiber than internal one. These values of diameter seem to be not much higher than mentioned in some other literatures, [13], that might be due to the variation in growth conditions. Wall thickness had no significant changes by changing levels of pollution or wood position, that means the increase or decrease in fiber diameter happened mainly in cell lumen affecting wood specific gravity.

Results of specific gravity reveal to some interesting observations which interpret the significance interaction appeared in table (1). Pollution level had no clear influence on the internal wood specific gravity (Table 3), while very clear effect could be observed on specific gravity of external wood. It was increased with the increase of levels of pollution, especially at the most two higher levels. It means that a higher density was obtained in the wood formed after pollution due to the forming of narrower fibers having the same wall thickness. Herein too, an interesting observation was found that the values of specific gravity were at their minimum levels mentioned by literatures dealt with wood of this tree species [2, 14].

Growth conditions and the size of trees could be the reason of obtaining lower density wood.

Some conclusions from the obtained results could be pointed; crude oil pollution has effects on some wood properties. It makes fibers of *Casuarina equisetifolia* shorter and narrower. Such findings could be explained according to obtaining higher specific gravity of wood for the outer layers that were added after pollution process.

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Table (1) Analysis of variance of fiber dimensions and specific gravity of the wood of *C. equisetifolia*

Wood Property	Level of Pollution (LV)		Specimen Position (SP)		Interaction LV x SP	
	df	Mean Squares	df	Mean Squares	df	Mean Squares
Fiber Length	3	15.24	1	1254.26 *	3	18.74
Fiber Diameter	3	11.47 *	1	13.20 *	3	13.88 *
Wall Thickness	3	0.092	1	0.093	3	0.125
Specific Gravity	3	0.0036 *	1	0.0015	3	0.0049 *

Means with (*) are significantly difference (LSD) at p<0.05

Table (2) Mean values of wood fiber dimensions of *C. equisetifolia* as affected by crude oil pollution and position within the stem.

Level of Pollution	Fiber Length (mm)		Fiber Diameter (μ m)		Wall Thickness (μ m)	
	Internal	External	Internal	External	Internal	External
L0	0.803	0.983	24.6	22.0	2.93	2.54
L1	0.817	0.972	19.4	24.1	2.67	2.93
L2	0.813	0.909	20.1	22.3	2.70	2.43
L3	0.803	0.949	19.2	20.8	2.90	2.80
Mean	0.809	0.953	20.8	22.3	2.80	2.68

Table (3) Effect of levels of crude oil pollution and specimen position on the specific gravity of *C. equisetifolia* wood.

Level of Pollution	Specific Gravity		Mean
	Internal wood	External wood	
L0	0.529	0.514	0.522
L1	0.519	0.503	0.511
L2	0.518	0.538	0.528
L3	0.520	0.570	0.545
Mean	0.522	0.531	0.527

تأثير تلوث التربة بالنفط في بعض صفات خشب *Casuarina equisetifolia*

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الخلاصة

أجريت التجربة لبحث تأثير تلوث التربة بالنفط الخام في بعض صفات الخشب لنبات *Casuarina equisetifolia*. استخدمت أربعة مستويات من التلوث على 40 شتلة بعمر سنة واحدة. أخذت النماذج عند قطع الأشجار بعد موسمي نمو من تاريخ التلوث. تمت دراسة أطوال الألياف وأقطارها وسماكات جدرانها والوزن النوعي للخشب الداخلي والخارجي. أظهرت النتائج تأثيرا عكسيا للتلوث في قطر الألياف بصورة اكبر مما حصل مع طول الليف، ولم تبد سماكة الجدار تأثيرا معنويا بهذا العامل. ظهرت أبعاد الألياف للخشب الخارجي اكبر من نظيراتها للخشب الداخلي ولاسيما لصفة طول الليف. تأثر الوزن النوعي للخشب بعامل التلوث متداخلا مع العامل الآخر فقد ظهرت زيادة ملحوظة للوزن النوعي مع ارتفاع مستوى التلوث للخشب الخارجي دون الداخلي أي للحلقتين اللتين تكونتا بعد عملية التلوث. ظهر بعض التباين في قيم أبعاد الألياف والوزن النوعي عما ورد في دراسات أجريت على النوع في مناطق أخرى قد يعود سببه إلى اختلاف الظروف البيئية للنمو بين المواقع.