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Ecological Study of *Avicenia marina* in Saudi Arabia Al-Qatif District East Saudi Arabia

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ABSTRACT

The aim of this work was to study the effect of soil pollution on *Avicenia* marina grown at Al-Qatif beaches in jubail region after 18 years of the 1991 Gulf War. Accordingly, soil samples were collected from four locations in Al-Qatif district 65 km. North Jubail region and one location at Shoiba, 140 km. south of Jeddah and chemically analyzed. Both upper and lower surfaces of *Avicenia marina* leaves were collected from three locations dominated by *Avicenia marina* in Al-Qatif, the forth location empty from that plant, and from Shoiba for chemical analysis to estimate the mineral contents in them. The soil in the four locations was poor, calcareous with high contents of calcium ions and lack phosphorous in three of them. The soil in all the four locations has small amounts of ferrous and potassium, while that of the fourth one has higher amount of aluminum. The soil in Shoiba was much richer in all the elements but lack in phosphorous. The density of *Avicenia marina* plants were low,but tall in the first three locations in Al-Qatif, while they were short and seems to be under stress in Shoiba. Leaves from the three locations of Al-Qatif, as well as those grown in Shoiba were analyzed, and mineral contents present in both the upaxial and adaxial surfaces were detected. sodium and chloride concentrations were higher in lower surfaces while calcium content was higher in upper surfaces. Mineral contents in the leaves collected from Shoiba were much higher than that in Al-Qatif district.

INTRODUCTION

Avicenia marina (Forsk.) Vierh. commonly known as grey or white mangrove, is a species classified in the plant family Acanthaceae (formerly in the Verbenaceae or Aviceniaceae) and occurs in the intertidal zones of the estuarine areas. In Saudi Arabia it is distributed along the Red sea and Eastern coastal regions, and its leaves considered as a nice meal to cows and camels. *Avicenia marina* (Forsk.) Vierh. is a tree grows to a height of three or four meters, with thick

lanceolate leaves. The upper surfaces of the leaves are glossy green, while their lower surfaces are hairy white or grey. The flowers are golden yellow and occur in clusters of three to five. The plant characterized by having aerial roots (pneumatophores) which grow to a height of about 20 centimeters.

Barth and Niestlė (1994) gave a description of the environmental effects of the 1991 Gulf War on the ecosystems in the area between Abu Ali and Rasa z-Zaur on Saudi Arabia. They mentioned that the thick layer of oil covered the tide zone damaged the vegetation in that area. Böer (1994) found that the salt marshes and mangroves of the Saudi Arabian Gulf areas are the most severely affected habitats after the Gulf War. Accordingly, many ecological works have been done to study the effects of this war and oil pollution on the salt marsh vegetation especially on *Avicenia marina*. Warnken (1994) found that the oil-impacted area was restricted to the upper one third of the intertidal area and the salt march vegetation was affected to such a degree that less than 1% of the plants survived and there was no evidence of generation after two years of the War. Mandura (1997) found that the mangrove in the Red Sea coastal area is very small with low pneumatophore density which affects the aeration area, respiration rate, nutrient rate and plant growth. Badr *et al.* (2009) pointed to the severe metal pollution in the Red Sea coastal region. They calculated the contamination factors (CF's) in the core sediments in all the studied areas and found that the contaminant elements were in the following sequences: Cd > Pb > Ni > Cu > Zn > Cr > Mn for all studied areas. Their results of Pollution Load Index (PLI) revealed that Jeddah is the most polluted area, followed by Rabigh while Yanbu is the least.

This study has been carried after about 18 years of the 1991 Gulf War on *Avicenia marina* (Forsk.) grown at Al-Quatif beaches in Jubail region to estimate how much this species was affected by the soil pollution.

MATERIALS AND METHODS

The study was carried out along two years, from June 2007 till May 2009 at Al-Qatif district, 65 North Jubail regions, eastern Saudi Arabia (map 1). The studied area has a lot of beaches on the Arab Gulf shore. Four locations have been chosen for this study in Al-Qatif districh in comparison to one location in the Red Sea coastal region. The fourth location in Al-Qatif destrict has no *Avicenia marina* at all, while the other three have moderate to dense communities of *Avicenia marina* (Forsk.). Monthly

Map1: *Jubail region at the Arab Gulf shore, east Saudi Arabia*

Photograph 1 of *Avicenia marina* at Al Nasra beach 2-fruit and leaves

visits were made to the four locations at Al-Qatif beaches (Snabis beach, Al-Nasra beach, Marine Cornish, and Al-Shatek district) as well as to the fifth location in the Red Sea coastal region called Shoiba, 140 Km south of Jeddah where there are mangrove saline lagoons (Fig.1).

Soil and plant samples have been taken in each visit to estimate their elements content using x ray analyses, in which the soil particles and parts ob both ab-and ad-axial surfaces of the leaves were exposed to x-ray beam to give estimation of the mineral contents in each specimens compared to know elements as shown in Table 1. The means of 24 readings were calculated.

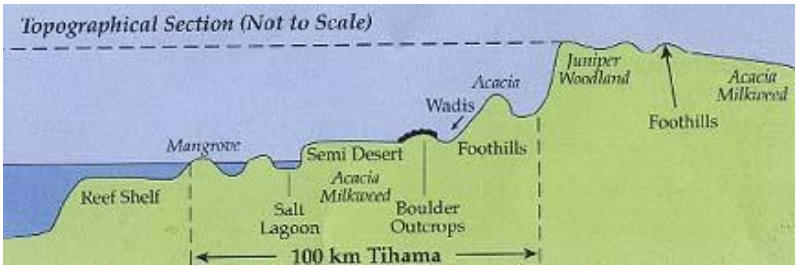

Fig.1: ***A typical topographic section from the west coast eastwards into the mountains starts at the Red Sea. Attractive mangrove-fringed saline lagoons at Shoiba, 140 km. south of Jeddah.***

RESULTS

In the Studied areas, communities of *Avecinea marina* seem to be under stress, they were weak and pale green, but the plants in Al-Qatif areas were taller than that in Shoiba area. From Table 1 and Fig.2, we find that the soil in Al-Nasra beach (Loc.2) was the highest in sodium chloride, potassium and sulphur contents and the lowest in ferrous content. Soil in Marine Cornish (Loc.3) has no sodium at all, but has low contents of chloride and sulphur and high in calcium and silicon contents. The ferrous content is reasonably high. Snais beach (Loc.1) has no sodium content at all, as Loc.3, but chloride content is higher than in Loc.3 and has the highest contents in manganese, sulphur, calcium, ferrous and phosphorus. Al-Shatek district (Loc.4) has low content of sodium chloride, high contents of manganese, aluminum, silicon and calcium but moderate in ferrous content. Locations 2,3 ,4& 5 has no phosphorous content at all.

From Table 2 and Figs.3 & 4 we can notice the differences in mineral contents in both the lower and upper surfaces of the leaves of *Avicenia marina* grown in the first three locations and the fifth location, the fourth location, Al-Shatek district, was completely empty from the *Avecinea marina* plant. From Fig.2 we find that within Al-Qatif district locations, location 1 (Snabis beach) has the highest contents of Aluminum and copper in both the upper and lower surfaces, then comes location 2 (Al-Nasra beach) and finally location 3 (Marine Cornish). Location 3 is the highest contents in silicon, calcium and phosphorus, while location 2 is the highest in sodium chloride contents (Figs. 3 & 4). The mineral contents in the fifth location, Shoiba, were too much higher than that in Al-Qatif district (Table 2 & Fig.2). In spite of that, the plants at Al-Qatif locations

Table 1: ***Means of elements content in the soil of the four locations compared to standard materials.***

Elements	Locations					Used Materials
	Al-Qatif district				Shoiba	
	Loc.1	Loc.2	Loc.3	Loc. 4	Loc.5	
Na	**0.0**	**11.55**	**0.0**	**1.86**	**38.9**	NaCl
Mg	**10.11**	**7.85**	**5.75**	**7.12**	**75.3**	MgO
Al	**5.23**	**5.08**	**2.88**	**6.00**	**42.8**	Al_2O_3
Si	**10.97**	**17.06**	**46.46**	**31.30**	**33.9**	Quartz
S	**3.40**	**10.14**	**0.77**	**1.69**	**62.4**	FeS_2
Cl	**1.55**	**13.11**	**0.74**	**2.90**	**36.9**	KCl
K	**1.36**	**1.68**	**1.55**	**1.45**	**65.9**	MAD
Ca	**60.85**	**32.81**	**39.67**	**46.34**	**92.3**	Wollas
Fe	**2.54**	**0.72**	**2.18**	**1.34**	**68.3**	FeS_2
P	**3.99**	**0.0**	**0.0**	**0.0**	**0.0**	GaP

were taller and look more healthier than those grown at Shoiba. In the Red Sea coastal region, the mangrove stand is very small and occupies an area of about 0.45 km². The trees are stunted with low pneumatophore density. The pneumatophore distribution is restricted to the area of substrate underneath the plant crown covers and they do not look healthy. A high proportion of them were observed to be

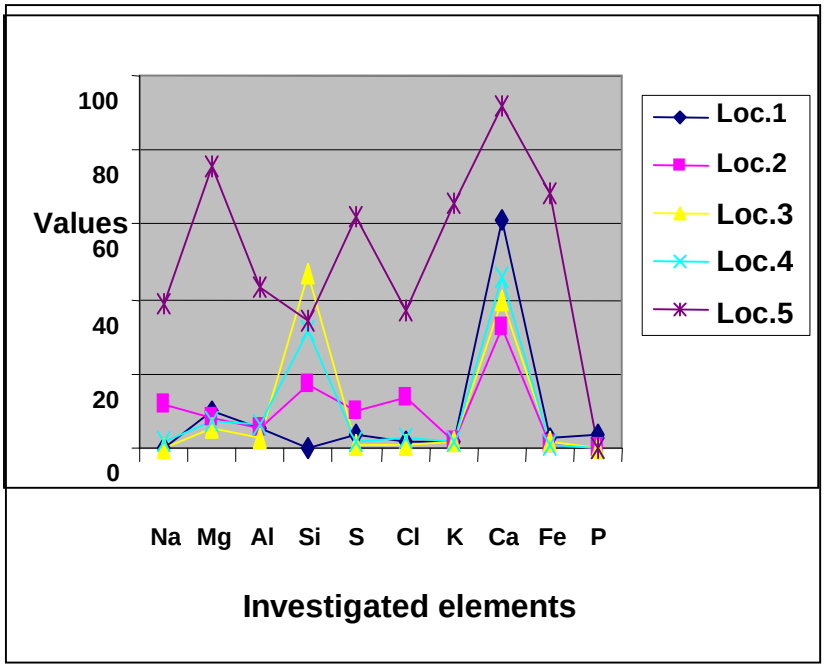

Fig. 2: ***Elements content in the soil of the 5 locations***

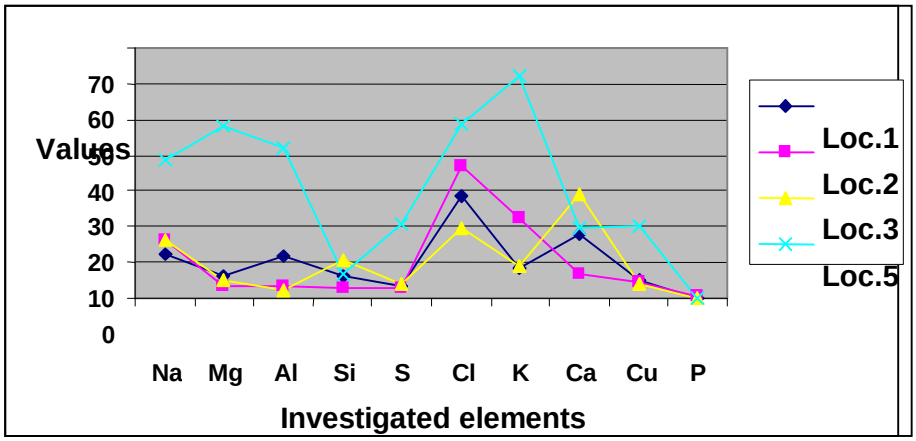

Fig. 3 Elements content in the lower surface of the leaves from the 4 locations

is very small and occupies an area of about 0.45 km². The trees are stunted with low pneumatophore density. The pneumatophore distribution is restricted to the area of substrate underneath the plant crown covers and they do not look healthy. A high proportion of them were observed to be dead and/or aberrant. These abnormal induced features were attributed to the sewage discharge in the area. The death of pneumatophores decreases the aeration area which apparently affects the respiration rate of the root system, elements uptake and plant growth, consequently leading to a retarded growth of the mangroves in that area. Thus the *Avecinea marina* looks under

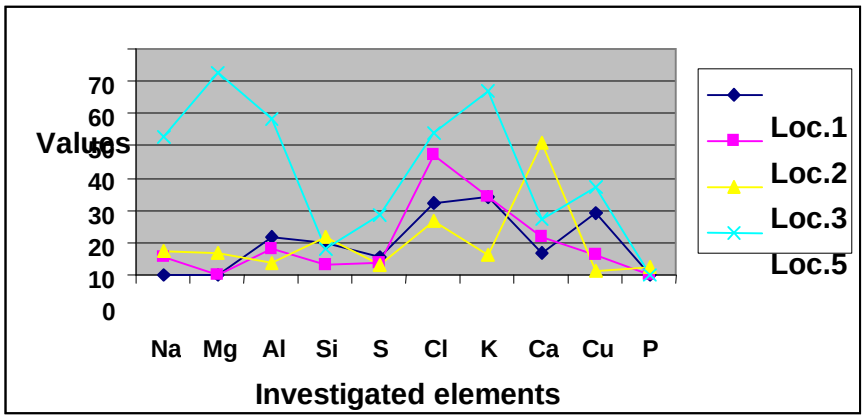

Fig. 4: ***Elements content in the upper surfaces of the leaves from the 4 locations***

Table 2: ***Elements content in both the lower and upper surfaces of the leaves from the 3 first locations in Al-Qatif; Snabis, Al-Nasra & Marine Cornish and the fifth location at Shoiba***

Elements	Locations					Used Materials
	Al-Qatif district				Shoiba	
	Loc.1	Loc.2	Loc.3	Loc. 4	Loc.5	
Na	**0.0**	**11.55**	**0.0**	**1.86**	**38.9**	NaCl
Mg	**10.11**	**7.85**	**5.75**	**7.12**	**75.3**	MgO
Al	**5.23**	**5.08**	**2.88**	**6.00**	**42.8**	Al2O3
Si	**10.97**	**17.06**	**46.46**	**31.30**	**33.9**	Quartz
S	**3.40**	**10.14**	**0.77**	**1.69**	**62.4**	FeS2
Cl	**1.55**	**13.11**	**0.74**	**2.90**	**36.9**	KCl
K	**1.36**	**1.68**	**1.55**	**1.45**	**65.9**	MAD
Ca	**60.85**	**32.81**	**39.67**	**46.34**	**92.3**	Wollas
Fe	**2.54**	**0.72**	**2.18**	**1.34**	**68.3**	FeS2
P	**3.99**	**0.0**	**0.0**	**0.0**	**0.0**	GaP

stress of contamination, in spite of that the mineral contents in both the upper and lower surfaces of the leaves were higher than those in Al-Qatif district as shown in Table 2.

DISCUSSION

Saenger (1993) described the mangroves in Saudi Arabia by being fragmented areas in the Red Sea and Arabian Gulf coast and consist of *Avicenia marina* trees accompanied by few examples of *Rhizophora mucronata*. The National Commission for WildLife Conservation and Development in 2007 described the Mangroves in Saudi Arabia by being widely scattered along the Red Sea and Gulf coasts. They recorded two species: *Avicennia marina* is the most common in both coasts while *Rhizophore mucronata* is found in eleven sites only in the Red Sea coast. This coordinates with our findings, where we cannot found any member of *Rhizophore mucronata* in Jubail Region. FAO (2002) announced that the mangrove ecosystems In the Arabian Gulf have been principally affected by the large oil spill from the Gulf War. Our results showed that the soil in the four studied locations is very poor in phosphorous and the other elementsas a whole. In spite of that the silicon and calcium are considerably high and this may be reason for the weakness and less density of the plants. While the elements content in the leaves shown high contents in chloride, potassium and calcium, this is logic to accumulate calcium and chloride ions in the leaves as these two elements are

the higher values in the soil, while potassium, which has role in opening stomata, must be accumulated in the leaves to control opening stomata. Sodium chloride concentrations are higher in lower surface than upper surfaces because of the emergence of the leaves in sea water. Calcium content in upper surfaces are higher than lower surfaces due to intensive sun exposure in these areas.

Location 4 has no *Avicenia marina* plants and this may be due to the poor, calcareous soil with high content of aluminum. Plants grown in locations 1 and 3 are considerably richer because they aren't under salt stress and the soil has higher content of ferrous. The soil in Shoiba was polluted with high contents of heavy metals and salts, due to sewage discharge in that area. The death of pneumatophores decreases the aeration area which apparently affects the respiration rate of the root system, elements uptake and plant growth, consequently leading to a retarded growth of the mangroves as mentioned by Mandura (1997) and Badr *et al.*(2009).

From this study we can conclude that *Avicenia marina* communities did not highly affected by the oil spill from the Gulf War, as they can overcome pollution and salt stresses, but the accumulated minerals can be affected to an extent that may alter its general appearance. Meanwhile the pollution in the Red Sea coastal region can destroy the mangrove community in that area.

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دراسة بيئية علي نبات الشورى النامي بشواطيء القطيف بالمنطقة الشرقية بالمملكة العربية السعودية

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هذه الدراسة تناولت تحاليل التربة وأوراق نبات الشورى النامية في أربع مواقع بمدينة القطيف, ٦٥ كم من الجبيل, ومقارنتها بموقع خامس يقع علي شاطئ البحر الأحمر بمنطقة شويبا, ١٤٠ كم من مدينة جدة. مواقع القطيف هي :- ١- سنابس ٢- الناصرة ٣- الكورنيش البحري شمال القطيف ٤- الشاطئ.
ومن نتائج هذه الدراسة وجدنا أن عناصر التربة في كل مواقع القطيف بالمنطقة الشرقية من المملكة العربية السعودية كانت شحيحة للغاية بينما كانت في منطقة شويبا علي ساحل البحر الأحمر أكثر بشكل كبير عنها في مواقع القطيف. بينما نبات الشورى النامي في الثلاث المواقع الأولي بالقطيف كان أكثر طولا بالرغم من قلة كثافة النبات وقلة العناصر المعدنية المتواجدة في كل من السطح السفلي والعلوي بأوراقه وأنعدم النبات تماما في الموقع الرابع (الشاطئ). أما نبات الشورى النامي بمنطقة شويبا كان قصير ويبدو عليه الذبول والإنهاك بالرغم من ارتفاع قيم العناصر المعدنية علي سطحي أوراقه.

١- نوقشت النتائج علي أساس الضغوط البيئية الواقعة علي المنطقتين حيث تلوثت مياه الخليج العربي بعد حرب الخليج مما أثرت علي الحياة النباتية بها وخاصة نباتات المانجروف. كما تعرضت شواطئ البحر الأحمر بالمملكة السعودية للتلوث من إلقاء مياه الصرف الصحي بها.