Environmental Studies on the Effect of Air Pollution on Natural Forests Deterioration of Juniperus (*Juniperus procera*) in Saudi Arabia

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Abstract: This study aims to evaluate the effect of air pollution by exhausts of different transportation means on *Juniperus procera* forest. Several forests were selected at Al-Baha region (western-south portion of KSA) which differs in traffic density. The study focused on air organs (leaves and branches) of Juniperus and the soil of the plant. Photosynthesis pigments, estimation of some minerals (Na, Ca, Mg, Fe, K, Zn, Pb), soil texture, soil EC, soil pH, estimation of mineral nitrogenous elements (Na, Ca, Mg, Fe, K, Zn, Pb) and amounts of sulfates, chlorides, bicarbonates salts .results revealed that there are significant differences between sites in the amount of photosynthesis pigments, increase in chlorophyll a and b with the increase of pollution degree. There are high significant differences between minerals in the plant, calcium recorded the highest values while sodium recorded the lowest values in the plant. Soil results, on the other hand, indicated that, there are high significant differences between sites in the soil texture, Ec and pH. Raghdan forest soil has the highest Ec, lowest alkalinity compared to other sites. The amount of Pb, sulfates, chlorides, Ca, Mg, Na and bicarbonates salts in the soil of Raghdan forest (of high traffic density) is significantly higher than other sites. This study has shown that (*Juniperus procera*) is of environmental importance has high potential for Adaptation to environmental stresses such as Traffic emissions, these plants used different methods to adapt such as the increase of photosynthesis pigments and accumulation of some elements in the plant tissue in sites with high traffic density, the main source of pollution and important heavy elements especially lead caused by emissions from vehicle exhausts.

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1. Introduction

The deterioration in ranges and forests leads to shrinkage and sometimes extinction of the plant cover for wide areas leading to reduction of wood and energy production leading to increase pressure over the natural resources (Alserwi, 2009). The Western South mountains represents the most variable areas in Kingdom of Saudi Arabia with high density of plant cover due to the elevation that reaches 3000m with abundant rains, and moderate temperature (Alnafie, 2004). Spread of mountain Juniperus forests which represents 95% from the areas of forests in the Western South part of the kingdom (Abu Alhasan, 1999). Contamination with heavy minerals is one of the factors affecting the world (Sidhimol *et al*., 2011). The means of transports are considered the most important sources of environmental pollution and found that the highest percentage of lead emission in air is from burning of the cars fuels (Alserwi, 2009). Lead in the current time is one of the most important heavy mineral polluting the environment and threatening the human health (Alodat, 2997).

The present research aims to evaluate the effect of air pollution with gases emitted from different means of transport on some features of *Juniperus procera* plants (Fig.1), the most abundance type in forests in western south part from the kingdom. In addition, the effect of traffic pollution on some features of soil that affect the growth and the productivity of the plant was also studied. By fulfilling theses aims, highlighting one of the most important environmental factors leading to extinction and deterioration of plants can be overcome.

2.Material and methods:

Three forests are selected in Al-Baha area, Al- Baha area (Fig. 2) lies in the Western South part from Kingdom of Saudi Arabia lines (41/42 vertical and 19/20 horizontal). Al- Baha area is characterized by moderate mountain weather in summer and cold in winter with presence of clouds, fog, however, the coastal part characterized by hot weather in summer and moderate in winter, the average temperature in mountain area reaches 17^{o}C and the average rain is 500ml, as the mountains heights decrease gradually towards the desert in east part, the area becomes more dry. Al- Baha area is famous of natural forests that covers most Alsrah mountains. The selected forests were: Raghdan forest (Fig.3) is a famous forest about 5km north from down town of Al-Baha city and is considered one of the best forests in Al-Baha area and one of the largest forests in Kingdom of Saudi

Arabia; Shahbah forest lies in east north of Al-Baha and is about 6 km away from city of Al-Baha and Alghemdah forest which is about 2km away to the south from Al-Baha city. Difference in traffic intensity has been taken into account. Transport intensity varies from being high in Raghdan area (site 1) to be less in Shahbah forest (site 2) and Alghemdah forest (site 3), Fourth site, away from traffic roads, (site 4) was selected to represent the least pollution with gases emitted from different means of transport.

Samples of plants from the upper parts of the plants (leaves and branches) from the trees lying on the traffic road in the three forests are collected together with soil samples from under the plant and from the root complex of the plant (from surface till depth of 30cm) . The soil samples were collected ,air dried then sieved with sieve which pores diameter is 2mm to separate stones and rocks, and estimate the form of the soil using different pores sieves according to system of the international association of earth sciences (Futh, 1985). Then measure the pH for the extract using pH meter (WTW mode 512), while the electrical conduction (Ec) is measured using EC-meter (Matter Toledo- AG) and mineral elements (sodium, calcium, potassium, magnesium, , iron, zinc, lead) were measured in the extract of soil using Atomic absorption Variance Spectr AA 10- Perk in Elmer Spect AA 3100 , using Photo Lab Spektral WTW to measure phosphorus , Nitrogen is measured using ionic separation using the apparatus (Ion chromatography Dionex 50), then determine amount of chlorides dissolved in aquatic extract off the soil using titration method with silver nitrate (Tilrator Mettler DL 55 (0.01N), while using ionic separation to determine amount of sulphates using ionic separation apparatus (Ion Dionex 50 chromatography), then determine amount of bicarbonates in the aquatic extract of the soil using titration method with hydrochloric acid (Tiltrator Mettler DL 55 (0.01N)).

Moreover, sodium calcium, potassium, magnesium, iron, zinc, lead were measured in the plant extract after digestion of plants according to method of Allen 1975 (Westrman, 1990). Determine the amount of stains of photosynthesis as the amount of chlorophyll is determined using the method of (Lichtenthaler, 1987) extracting it from known weights of fresh plant leaves (0.2) and putting them in test tubes then add 5ml (dimethyl formamid) then wrap the tubes with aluminum papers and cover with parafilm papers and leave in refrigerator for 24 hours then filter the extract and measure the degree of the absorption for this extract using spectrophotometer at the wave lengths 664.5, 647, 452.5 nanometer, using the following equations then measure the stains of the photosynthesis:

Chlorophyll a = 12.7 A664.5 – 2.79 A647.0 = μ/ml

Chlorophyll b = 20.7 A647.0 – 4.62 A664.5 = μ/ml

Carot. = 4.2 A452 – (0.0264 Chlorophyll a + 0.426 Chlorophyll b) = μ/ml

These results is estimated from the original sample weight and express the amount in milligrams for each gram of the fresh material and care for estimation of dilution.

Statistical analysis:

The statistical analysis of the results was done in terms of means and standard errors (± SE). In addition one way analysis of variance (*ANOVA*), using SPSS (SPSS, 2012) computer program.

3.Results :

Soil Characters :

The results of chemical and mechanical analysis (Table 1) for the soil in different sites shown that silt represents the highest percentage between soil granules in all places of study, the percentage in Raghdan forest soil was 46% and increased in other sites, reaching 71% in Shahbah forest, 61% in Alghemdah forest and 55% in site 4. On the contrary, sand particles percentage was low. It was 44% in Raghdan forest, 13% in Shahbah forest, 24% in Alghemdah forest and 27% in site 4, while for amount of silt ranged between (10, 16, 15.2, 17%) in Raghdan, Shahbah, Alghemdah and site 4, respectively. Therefore, the soil considered as silt soil in all site in the study area, even it differs from site to other. except in soil of Raghdan forest, wherebit is considered as sandy slit.

Also clarify that that the soil was slightly alkaline in Raghdan forest and site 4 (6.8) and (6.9) respectively, alkalinity rises more in forests of Shahbah and Alghemdah, (7.1) in both sites (Table 1). It is shown that the highest degree of electrical conduction (3385 milimos/cm) was recorded in soil of Raghdan forest, compared to other sites

Soil mineral elements (Table, 2), showed highly significant differences in contents of sodium, potassium, magnesium, calcium and zinc, also amount of phosphate, sulfate, chloride, while there is no significant difference between sites in contents of lead, iron, and nitrogen the values generally are high in soil of Raghdan in terms of calcium (657 mg/liter), magnesium (68.4 mg/liter), sodium (65.6 mg/liter), lead (0.685 mg/liter), amounts of both chlorides (360.5mg/liter), sulfates (787.5mg/liter), bicarbonate (103mg/liter) compared to other sites.

plants Characteristics:

The Results in Fig.(4) indicates that there is significant difference in the amount of chlorophyll A, B and the percentage of chlorophyll A to chlorophyll

B between the different sites, while there are no significant difference in carotene content in plant in all different sites. Unexpectedly, the results showed an increase in chlorophyll A and chlorophyll B with the increase in concentration of pollutants that accompanied with the increase in traffic movement. This was clear in Raghdan forest, where the amount of chlorophyll A, B were (26.3mg/g), (19.1mg/g) and reaching the lowest value in site 4 (17.3mg/g), (11.4mg/g).

On the other hand, the result in Fig. (5), showed high significant differences between different sites of elements. Moreover the increase in the amount of elements in plants followed the increase in concentration of pollutants, with the calcium elements recorded the highest values, compared to other elements.

Fig.(1):Juniperus procera in Raghadan forest.

Fig.(2): Site Al- Baha area (the study area) in the Western South part from Kingdom of Saudi Arabia.

Fig.(3): Raghdan forest and It seems clear impact road construction traffic on the deterioration of forest

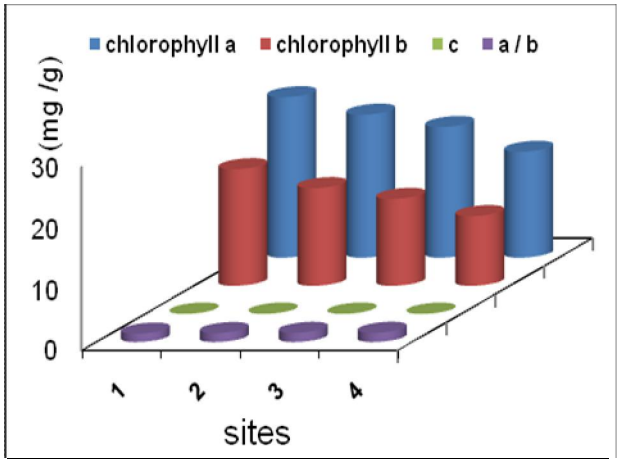

Fig.(4):the amount of photosynthesis pigments of *Juniperus procera* from different forests.

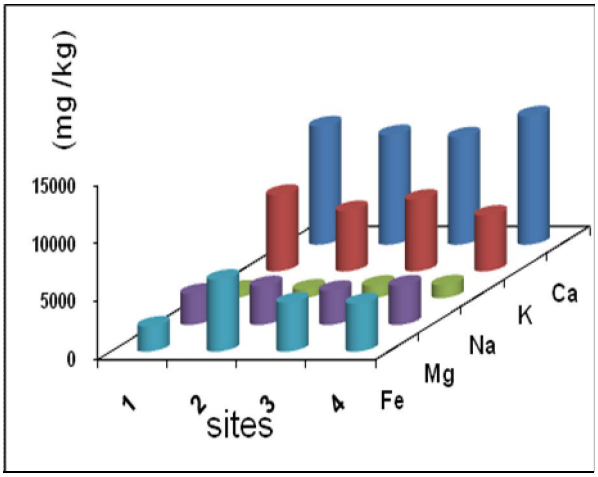

Fig.(5): Chemical analysis of *Juniperus procera* from different forests.

Table (1): Soil Fraction, ECe and pH of soil for *Juniperus procera* from different forests.

Sites	Soil Fraction (%)			EC mmohs/(cm)	pH
	Clay	Silt	Sand		
1	10 ± 0.27	46 ± 1.02	44 ± 1.23	3385 ± 598	6.8 ± 0.00
2	16 ± 0.93	71 ± 0.93	13 ± 0.52	336 ± 48.8	7.1 ± 0.03
3	15.2 ± 0.22	60.4 ± 1.07	24.1 ± 1.11	563 ± 6.06	7.1 ± 0.03
4	17.3 ±1.11	55 ± 1.32	27.3 ± 1.47	341 ± 18.19	6.9 ± 0.06
Sig.	**	**	**	**	**

* significant ** high significant

Table (2) : Chemical analysis of soil for *Juniperus procera* from different forests.

Sites	Mineral elements (mg/L)											
	Ca	K	Na	Mg	N	P	Fe	Zn	Pb	HCO_3	Cl	SO_4
1	657± 121	1.3± 0.52	65.6±10.2	68.4 ± 12.5	1.86± 0.84	1.56± 0.11	<0.10	6.15± 0.20	0.685± 0.08	103 ± 12.1	360.5± 72.5	787.5± 96.7
2	41.3± 5.20	1.8± 0.26	18.7± 5.11	3.6 ± 0.41	1.13± 0.10	0.76± 0.17	0.63± 0.27	1.51± 0.27	0.515± 0.11	66 ± 2.31	11.5 ± 4.91	122.5±1.44
3	80.7± 5.40	23 ± 0.61	3.1 ± 0.23	13.9 ± 0.09	2.63± 0.91	13.4± 1.07	0.27± 0.07	6.68± 0.41	0.540± 0.11	77.5± 6.64	< 1.0	147.5± 1.44
4	45.8± 2.08	1.8± 0.03	5.25±0.03	6.4 ± 0.09	1.13± 0.07	0.45± 0.08	0.22± 0.03	1.68± 0.03	0.485± 0.03	59.5± 8.37	< 1.0	132.5± 1.44
Sig.	**	**	**	**	N.S	**	N.S	**	N.S	*	**	**

* significant ** high significant N.S non significant

4.Discussion

The present study was an attempt to evaluate the effect of traffic activity and The air pollutants emitted from different means of transport on some forests which differ in traffic density at Al-Baha region (western-south portion of Saudi Arabia). Cars and different means of transport are the main source of air pollution especially in the towns (Alodat,2007). In addition, (Harrison *et al*., 1981; Roy *et al*., 1981; Zhang *et al*., 1995 and Badino *et al*., 1998) reported that the highest concentrations of heavy elements such as lead ,zinc, manganese and iron for all of their studies samples connected with high traffic movement and density. This is an important indicator for accumulation of elements emitted from vehicles engines on long-term leading to increase of pollution rate.

This study was made at Juniper forests, where more vegetation patterns are affected by human-induced pollutions (Migahid, 2006). Juniperus plant is one of the main vegetation groups in Saudi Arabia (Ministry of Agriculture and water, 1984), spreads at Alsarawat mountains constituting juniper forest which representing 95% of forests area. Juniperus grows in mountains above 1700m above sea surface, increase intensity in mountains higher than 2000 m above sea surface level (Zohary, 1973). follows the species of (Cupressaceae) which is one of the oldest tree living in Kingdom of Saudi Arabia as some trees reaches thousands of years (Chaudhry, 1999). The plant study (*Juniperus procera*) is a long living tree present in the kingdom in the western mountains south of Taif, and present in the world in Yemen and mountains in east Africa in Sudan and Ethiopia, then south to east Congo, and east north Zambia (Alnafie, 2004).In addition to the plant medical value , its uses in folk medicine and modern medicine are widely known as is mentioned by several researchers (Alshanawani,1996; Rifaat,2003; Shams Al-din, 2006 and Alkahtani, 2008).

The soil pH ranges from weak acidic at sites 1 and4 to weak alkaline at sites 2 and 3. Nevertheless, it was near the neutral point ,the optimum pH for plant growth (6.5-7.5), as was reported by (Migahid, 2009). The study clarified the high significant variation in electrical conductivity at different sites, where it is highest level in Raghdan forest soil compared to other different sites. There is a positive correlation between the increase of electrical conductivity of soil's solution and all mineral elements in addition to chlorides which act as anions connecting with the elements in the soil leading to increase of soil salinity (electrical conductivity).

The results showed the difference of mineral elements concentration between plant and soil in all studied sites. The outcome of mineral elements in the plant indicates that calcium is the most accumulative element inside the plant and in the soil. *Juniperus procera* contains many compounds around 80 compounds , alkaloids , organic acids and cardiac glycosides in addition to salts ,calcium is the most Important one(Alkahtani,2008). The potassium level recorded decreased at all sites but the concentration of potassium in the air branches was higher than its concentration in the soil which indicates necessity of potassium to plants in the different vital activities. Plants need potassium at high levels to activate some enzymes and act an essential role in water balance inside the plants ,in conversions of some carbohydrates. Despite of potassium availability in the crust but almost it is unavailable for plants (Omar, 2009).

The present results clarify that the decrease in sodium accumulation in the plant tissues comparing with other elements may be due to the high potassium concentrations which caused antagonism between them . It is noticed the lack of iron and magnesium in the plants of Raghdan forest which may be due to the plant need for both elements and consumes them in photosynthesis process. Iron plays an important role in chlorophyll construction and lack of this element causes mosaic leaves (Ingested, 1973). Magnesium, on the other hand, is important constituent of chlorophyll (Buran , 2009). Generally, magnesium is available to the plants through ionic exchange in the organic compounds or the mud which contains high level of magnesium, the lack of this element in the soil is due to presence of

high sodium, potassium and calcium concentrations (Omar, 2009) .

The present results indicate the significant variations of zinc concentrations among the different sites soil which may be contributed to role of weather factors especially wind that can help in transmitting and spreading the pollutants. The same is true concerning zinc amounts inside the plant leaves.

Moreover, the presence of highest level of lead element presents in the soil of Raghdan forest where the highest traffic density among the sites .some lead compounds are added to car fuels(benzene)to relieve the intensity of engine Explosion which are used at wide range globally. the lead percent in the air depends upon the traffic motion and density (Buran, 2009). Lead accumulates easily in the soil and different plant parts (Sharma and Dubey, 2009). but the lead accumulation highly in the roots and definite amount transmit to the other plant parts due to presence of natural plant barriers in the root (interior epidermis) (Sengar *et al*., 2008). The concentrations of the lead is significantly high in the airy branches of *Juniperus procera* growing at Raghdan forest more than other sites. the amount of lead is relatively high in the green leaves due to the deposits of air pollutants (Koeppe,1977, Zimdahl and Koeppe, 1979, Adriano, 1986). Lead exists naturally in all plants ,soil, water and air. The normal concentration in the leaves and small branches of wooden plants reaches 2.5 mg/kg dry matter (Who, 1977 . Singh *et al.*, (1997) Stated that some plants are able to tolerate excess amount of lead by different ways such as elimination, reservation or construction of antagonistic elements against the toxicity of it as plant chelating elements.

Many researchers studied the effect of lead on the photosynthetic pigments content in the plants by various concentrations, the researches indicate great decline of photosynthetic pigments content at high lead concentrations (Sidhimol *et al*., 2011). The total photosynthetic pigments content deceases with high concentrations of heavy elements such as lead (Zengin and Munzuriglu, 2005). Lead decreases photosynthesis rates of plants through the decline of chlorophyll construction due to Chloroplasts malformation, inhibition enzymes of Kelvin cycle (Sengar *et al*., 2008). But the results of the present study showed an increase of photosynthetic pigments (chlorophyll a and b) with the combination of high lead concentrations in the soil and plant which indicate the tolerance ability of this plant to this pollutant. There is significant variations in photosynthetic pigments amount, the highest percent at Raghdan forest and the lowest percent at site 4. There was significant variation in the amount of chlorophyll (a / b) at the traffic roads which indicates the effect of pollutants on both chlorophylls types in the plants at different sites. There isn't significant variation in carotenes amount at all sites. the scientists (Zhang *et al.,* 2011) found that there is high amount of chlorophyll a, chlorophyll b and carotenes at high concentrations of lead and cadmium . Abdel Ghaffar *et al*. (2000) Concluded that most copper and lead factors lead to increase in photosynthesis pigments in wheat but do not affect the inter-correlations among chlorophyll a, chlorophyll b and carotenes.

5. Conclusion:

The *Juniperus procera* plants were high environmental value and the main plant at Western-South forests in Saudi Arabia. This plant has high ability to adapt the environmental stresses in terms of traffic emissions, by using different adaptation strategies such as increasing the photosynthetic pigments and accumulating reasonable amount of heavy metals despite the heavy traffic nearby. Accumulation of heavy metals inside the plant tissues such as zinc and lead at Raghdan forest plants at the sites of high traffic density, indicates that air pollution by vehicles exhausts emissions is the main source of pollution. the traffic activity is the main source of pollution by heavy elements especially zinc and lead.

The study recommends to do more investigation of the physiological studies about how *Juniperus procera* can resist environmental stresses such as the traffic emissions that increase the concentration of heavy elements in the plant, and put an effective laws to protect forests from vehicle exhausts . And the most important of them, do not construct roads through forests so that we can control one of the most important environmental factors that affecting in degradation and extinction of forest.

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