RESEARCH PAPER

Response of Plane Tree (*Platanus orientalis L.)* toward Environmental Pollution of Erbil City

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ABSTRACT

The objective of the present study was to evaluate the leaves of plane tree (*Platanus orientalis* L.) impaired by traffic pollution. Trees from four locations of Erbil City were investigated. Leaf morphology, leaf and soil heavy metal concentration and leaf pigments were measured from the collected leave samples. One way ANOVA was used to compare means and determine significant variation among the studied parameters. The highest increase in chlorophyll a and total chlorophyll were obtained in Sami Abul-Rahman Park-whereas, the highest reduction was observed in Ainkawa road. Likewise in case of carotenoid contents, non significant effect was obtained from samples. The study obviously points out that the motor vehicles stimulate air pollution may result in decreases the concentration of photosynthetic pigments in the plane trees exposed to road side air pollution. It is shown that the lowest metal concentrations were detected in Sami Abul-Rahman Park in comparing with the other locations. It is shown that the lowest metal concentrations such as Ni, Zn, Mn and Fe in soil and plant samples were detected in Gulan Street When compared with the other locations. According to the geoaccumulation index (I_{geo}), the soils were classified into uncontaminated and uncontaminated to moderately contaminate.

1. INTRODUCTION

Air pollution is a severe problem in many industrialized regions in the world (Kambezidis *et al.,* 1996). Environmental conditions and air pollution expose trees to different stresses and decrease growth. Dineva ,

(2004) believed that urban trees can be used to mitigate the effect of air pollution in areas with polluted environment. In addition, it is mostly documented that planting trees in industrial locations are fundamentally influenced by different pollutants such as particulate matter and gases like HF, Ozone etc. (Dineva, 2004). It has been shown that in many urban areas of the world a major source of air pollution is motor vehicles traffic which contributing 57–75% of total emissions (WHO 2006). Sawidis *et al.* (2001) stated that rural areas have lower pollution than metropolitan areas. Studies showed that plants develop different morphological and anatomical modifications under polluted conditions (Veselkin, 2004).

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One of the most important services of forest trees is regulating services particularly in urban cities. A study conducted by Beckett *et al.,* (2000) showed that air quality through filtering and taking up gases and particles can be improved via trees in the urban environment there is a difference between forest trees species in responding to air pollution. Urban trees are of high essential component in urban areas for the inhabitants, but may also be in danger of extinction by experience to pollution. Plane tree (*Platanus orientalis* L.) is originally native to South Western Asia. It is a large deciduous tree known for its longevity and spreading crown. It can be planted from different elevations up to nearly 2500 meters above sea level (a.s.l) and the species is growing up to 30 m tall. In Erbil city the tree is usually used for the purpose of shedding along with the streets and parks. The main objective of the study is to assess the response of *Platanus orientalis* L. to environmental pollution on in Erbil city.

2. MATERIALS AND METHODS

2.1. Leaf sample collection

The research was studied leaves from common urban plane tree. The leave samples were collected from four locations during November 2019. Samples were taken randomly from each tree from the south and Northern sides of the crown at about more than I m height of every trees from all locations. Overall 120 leaves were gathered from all locations and the number of leaves per tree would be 10 leaves. Tree sampled at each of the four locations: L1 (Sami Abul-Rahman park) as a control, L2 (60 Meter street), L3 (Ainkawa road) and L4 (Gulan street) they had an identical height and growth form the sampling locations (Figure 1).
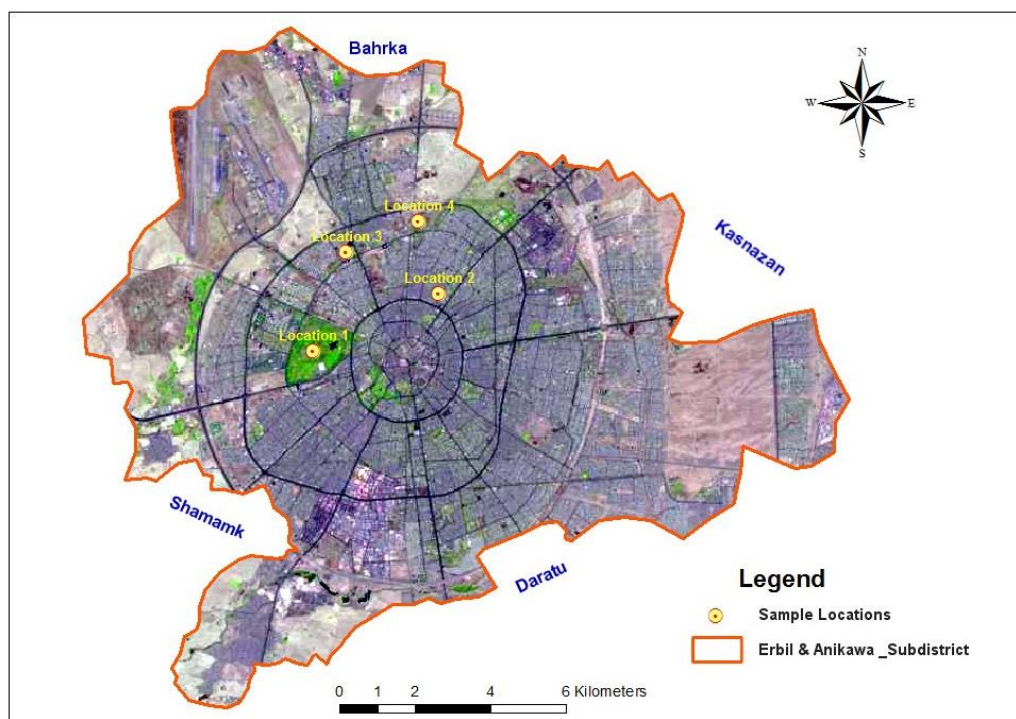

Figure 1. Sampling locations of *platanus orientalis* L. tree leaves and soil.

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2.2 Study parameters

2.2.1. Leaf morphology

After cutting leaves from trees immediately they were placed in plastic bags and were imparted on ice to the laboratory. Leaf length and leaf width were measured by a ruler according to method as mentioned by(NeSmith, 1991). Leaf samples were collected from four locations. The leaves were duplicated on A4 sheets with knowing their areas and weight, the leaves were accurately marked and weighed. The area was calculated on portion and portionality scale, to obtain the leave area of whole tree by multiplying the number of leaves by the mean of area one leave (Patton, 1985).

2.2.2. Heavy metal concentration in leaves and soil samples (mg kg^{-1})

Leaves and soil samples were directly analyzed by XRF (X-Ray Fluorescence analyzer) method after drying, sieving by 2mm and powdering of the material. Leave and soil samples were analyzed by XRF method and heavy metals were measuring by portable (CIT-300 SMP) (Sitko *et al*., 2004), in general laboratory -College of Agricultural Engineering Sciences-Salahaddin University. For the evaluation of soil contamination by heavy metals.

Geoaccumulation index (I $_{geo}$), the pollution indices may differ from each other due to several factors that affect their importance (Kowalska *et al.,* 2016).

Geo-accumulation index (I$_{geo}$) = log2 Ci / (Cig*1.5)…………… ………….. (1)

Where Ci is the measured concentration of the studied metal in the surface soil

Cig is the geochemical background concentration or reference value of the metal, and 1.5 is constant that is used for litho logic variations of the heavy metal. Calculation of soil pollution indices needs the evaluated level of the geochemical background (GB). This term was presented to discriminate natural concentrations of heavy metals in the soil from unusual concentrations (Reimann and Garret 2005). Geo-accumulation index (Igeo) as a single index was primarily defined by (Muller, 1979) to affirm metal contamination. Geo-accumulation index is a simple, precise widely used quantitative method to assess the pollution level of a single heavy metal in soil by depending on the geological background (BG). Igeo index can compare between the present and past pollution levels. Furthermore, Igeo index uses the multiplication factor of (1.5) to minimize the possible variation of lithogenic effects.

2.2.3. Chlorophyll determination

Healthy and uninfected leaves were collected at the stage of maturity; and to avoid mechanical injuries care was also taken into consideration during collecting of leaf samples. Fresh leaf samples were needed to be lotion cautiously first with drinking water and after that by distilled water in the laboratory, kept to dry in room temperature (28 °C). The solution mixture was analyzed and spectrophotometric determination absorbance taken at 663.2, 646.8 and 470 nm for analyzing the determination of Chlorophyll-a, Chlorophyll-b and carotenoids contents as presented by Sumanta *et al.,* (2014)

2.2.4. Data analysis

SPSS statistical analysis software version 25 was used to perform statistical analysis at p < 0.01 level of significance.

3. RESULTS

3.1. Leaf growth

From the data obtained in this study, there were differences among the locations (97.3 and 161.4 cm^2) in leave area of *P. orientalis* (Table 1). Mean leaf area of the collected samples in L4 was observed a significant difference in comparison with the mean leaf area of the other locations (Table, 1). Whereas, non significant variations were found between location 1 and other locations respectively. The higher mean of leaf length and leaf width were found in location 1 (control) when compared to other locations, on the other hand, the lowest mean values of them were obtained from location 4 for the same parameters (Table 1), this finding can be explained by entering pollutants in the form of gases such as O$_3$ and SO$_2$, throughout openings and closing of leaf stomata. Table (2) shows the significant effect of locations on concentration of photosynthetic pigments in *P.*

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orientalis L. tree leaves. It is found that the highest increase in chlorophyll 'a' content of the samples collected from location1 in comparison with samples collected from other locations which was obtained in *P. orientalis* L. (1.87 mg g^{-1} FW), while the minimum value was observed in location 3 (1.53 mg g^{-1} FW). In addition, the elevated mean of total chlorophyll was found in location 1 (control) which was (2.60 mg g^{-1} FW) (Table 2).

Heavy metal concentrations in leaf sample compiled were acquired in categorizes to be Mn, Cu, Zn, Ni, Pb and Fe, in that order (for identification of location numbering see Table 3). Mn concentrations in the leaf samples gathered from control site (L1) was extended from 125.2 to 402.6 (L4), whereas the range was found to be from 0 (L2) to 150.8 (L3). The Cu concentrations were detected as 64.4 (L1), 76.96 (L2), 76.8 (L3), and 76.47 (L4). However, the highest concentration of Zn and Fe were obtained in L2, whereas, maximum concentration of both Ni and Pb were accumulated in the leave samples collected in L3 and L1 (Table 3).

Table 1. Leaf morphology of *P. orientalis* L. tree measured at different locations.

Locations	LA (cm^2)	Leaf length (cm)	Leaf width (cm)
	Mean ± SD	Mean ± SD	Mean ± SD
L1	161.4 ± 34.5[a]	17.09±1.81 [a]	20.02 ± 2.40 [a]
L2	141.5 ± 41.6[a]	14.87±2.12 [ab]	15.41 ±1.97 [bc]
L3	148.1 ± 34.3[a]	16.3 ±1.71 [ab]	17.32 ± 2.11 [b]
L4	97.3 ± 8.1[b]	14.39 ±1.29 [b]	13.65±2.11 [c]

Table 2. Photosynthetic pigments concentration in *P. orientalis* tree leaves atdifferent locations.

Locations	Chloropyll a (mg g^{-1} FW)	Chloropyll b (mg g^{-1} FW)	Total chloropyll (mg g^{-1}FW)	Carotenoids (mg g^{-1} FW)
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
L1	1.87± 0.11[a]	0.78 ±0.10[a]	2.60± 0.11[a]	0.76 ± 0.12[a]
L2	1.72 ±0.07[ab]	0.73± 0.12[a]	2.45 ±0.19[ab]	0.63 ± 0.07[a]
L3	1.53±0.07[b]	0.56± 0.12[a]	2.09± 0.19[b]	0.55 ± 0.12[a]
L4	1.60±0.02[b]	0.63± 0.10[a]	2.23 ±0.08[ab]	0.55±0.13[a]

Table 3. Metal concentration in mg g^{-1}(dw) in leaves of trees at different locations.

Locations	Mn	Cu	Zn	Ni	Pb	Fe
L1	125.2	64.4	42.6	52.3	7.46	3000
L2	ND	76.96	50.86	74.4	6.88	4000
L3	150.8	76.8	33.46	77.8	7.12	3400
L4	402.6	76.47	39.01	77.5	6.17	3200

ND= not determine

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3.2- Effect of air pollution on soil

3.2.1-The Effect of different locations on Heavy

Metals Concentrations (mg kg^{-1}) in Soils.

The locations affected the heavy metals concentration in the soil. The results in the table (4) show that there was a considerable variation within location for the total concentration of heavy metals. Location 4 which had high total Pb and Cu concentration (ranking second), and in total Fe, Ni , Zn and Mn concentration (ranking fourth).). In general, the concentration of the studied heavy metals were higher from the soils of location 3 the concentration of most of the studied heavy metals present together in total Fe, Ni, Pb and Mn concentrations (ranking first), and in total Zn concentration (ranking second), and in total Cu concentration (ranking fourth), followed by location 2 which ranked first in total Cu and Zn concentration, and in total Ni concentration (ranking second), and in total Fe and Mn concentration (ranking third), and in total Pb concentration (ranking fourth).

Table 4. Element concentration mg kg^{-1} of the soil samples measured by portable x-ray Fluorescence.

Locations No.	GPS Reading			Heavy metals mg kg^{-1}					
	Latitude N	Longitude E	Elevation (m)	Mn	Cu	Zn	Ni	Pb	Fe
L1	36.1864	43.9780	379	216.20	44.00	81.50	185.80	1.08	32100
L2	36.2026	44.0164	437	168.01	54.15	98.67	193.31	0.98	30000
L3	36.2125	44.0133	431	249.39	38.84	98.36	246.88	1.53	33400
L4	362193	439948	396	9.52	39.48	71.44	136.88	1.16	17500

N= Northern, E=Eastern

3.2.2. Geoaccumulation Index (I $_{geo}$)

The index of Geoaccumulation scale consist of seven grades (0 - 6) ranging from unpolluted to very high polluted, these seven descriptive classes are as follows < 0 = practically uncontaminated; 0 - 1= uncontaminated to moderately contaminated; 1- 2 = moderately contaminated; 2 - 3 = moderately to highly contaminated; 3 - 4 = high contaminated; 4 - 5 = highly contaminated to very highly contaminated; > 5= highly contaminated soils. The control samples were taken to represent the background (Forstner *et al.,* 2014). Based on the above grades the geoaccumulation index (Igeo) as a one of the pollution parameters classified the soil in to two groups uncontaminated to uncontaminated moderately contaminated.

Table 5. Geoaccumulation Index of Metals in the Soils.

Soil samples	Mn	Cu	Zn	Ni	Pb	Fe
			Igeo			
L1	0.0	0.0	0.0	0.0	0.0	0.0
L2	0.51	0.44	0.41	0.11	0.0 >	0.0 >
L3	0.11	0.0 >	0.40	0.60	0.75	0.0 >
L4	0.0 >	0.0 >	0.0 >	0.0 >	0.0 >	0.0 >

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4. DISCUSSION

4.1. Pollution and leaf growth

The main part to determine the response of tree growth in polluted sites is the structure of tree foliage. The data of the study showed that the higher leaf area of the control can be due to trees less exposed to pollutants and differences in characteristic of leaf area give consideration to alter in leaf area index (Kardel *et al.,* 2010). Balasooriya *et al.,* (2009) concluded that there are others studies gained the same results an increase in leaf area of different species, on the other hand measuring leaf anatomy such as stomata density is also a good indicator for comparing influence of polluted and unpolluted sites. A study conducted by Jahan and Iqbal (1992) who found a decrease in leaf morphology such as leaf area, leaf length and width for some woody selected growing in urbanized polluted regions . In addition Gupta and Ghouse (1988) documented a diminishing of leaf area for *Euphorbia hirta* plant in smoked environment coal site as compare to the control site and this may support the present finding. Tiwari *et al.,* (2006) observed that improvement of leaf senescence and reducing of foliage can cause a decrease in leaf area. In addition, another reason for leaf area decreasing can be due to reduced irradiation absorption and consequently decreasing in photosynthetic process (Tiwari *et al*., 2006). Furthermore, encouragement of photosynthetic activity in higher rates of CO_2 in the atmosphere was deterioration by total leaf area reduction (Noormets *et al.,* 2001). Many researchers studied the leaf morphology characters which observed the same results between plants that are growing in air polluted territories.

The most common parameters used to determine effect of increased air pollutants on tree growth is net photosynthetic rate (Woo *et al.,* 2007). It is known that photosynthetic pigments such as carotenoid and chlorophyll a, b are playing a considerable part in photosynthetic process. In the finding study a reduction in cholorophyll a and total chlorophyll may be due to traffic density in the study sites. Joshi and Chauhan (2009) explained that a reduction of chlorophyll and carotenoid content is mainly caused by restraint of photosynthetic performance in leaves of different plants. The reductions in chlorophyll 'a', chlorophyll 'b' and total chlorophyll owing to air pollution was found in a study by Joshi and Chauhan (2009). A research by Chauhan and Joshi (2009) noticed that pollutant such as particulate matter, SO_2, NO_x and CO_2 may lead to a decrease in the concentration of photosynthesis pigments, chlorophyll and carotenoids when above pollutants absorbed by the leaves. When we compared the location 1 as a control to other studied locations, it is essentially carried out by using *P. orientalis* as an identical species, it was observed comparatively differences according to the site and studied species besides the heavy traffic density effects. For the most part of the research acquired a decrease in the concentration of heavy metals in the control samples. However, from leaf samples compiled Pb concentrations in location 1 showed slightly higher compared to the leaf samples with other locations.

4.2. Pollution and soil samples

4.2.1. The Effect of different locations on Heavy Metals Concentrations (mg kg^{-1}) in Soils

The location 1 which ranked first in total Mn and Fe concentration (ranking Second), and in total Pb, Ni, Cu and Zn concentrations (ranking third), the location (4) showed a low levels of heavy metals present together , this may be due to the accumulation of heavy metals in the soils was probably related to anthropogenic source (Gjoka *et al.,* 2011).The high value of heavy metals may be due to air pollution that contain high amount of metals as a result of dust or smokes of vehicles and industries and this agree with (Fay *et al.,*2005) However some authors prefer to use average shale composition as back ground (Tijani *et al.,* 2004).

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4.2.2. **Geoaccumulation Index (I $_{geo}$)**

This Geoaccumulation index has been extensively employed in European trace metal studies. It is shown that originally used for foundation sediments (Muller, 1979), and has been effectively practical to the measurement of soil contamination. This is appropriate if the samples are analyzed for total metal content. In the present study, the soil samples were analyzed for their partial extractable metal content, which represent mainly the mobile fraction of the elements. Table (5) is a diagrammatic presentation of the pollution levels of the various metals at the different sampling locations derived from the geo-accumulation indices. Soils can be described as uncontaminated and uncontaminated to moderately contaminated.

5. CONCLUSION

Morphology and physiology as well as heavy metal concentrations in leaves and soil samples of *Platanus orientalis* L. trees were studied to observe influence of high density of traffic roads. It is a species can be successfully planted along road sites and parks as an ornamental tree and ability to assemble the atmospheric pollution this attribute may be used as a biomonitor, as an alternative of using others methods such as costly play a part in pollution monitoring. The outcomes of this research revealed that the pollution level of the various locations within the study area was placed under uncontaminated to moderately contaminate classes, conducting extensive investigations on the sources of air pollution impacts on the environment and increasing public awareness about this serious environmental issue through education and publishing brochures in neighbourhood areas are way to improve this issue.

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Conflict of Interest

We do not have any conflicts of interests.

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