Evaluation of Heavy Metals Contaminated Soil in Relation to Leaf Characteristics of *Ficus nitida* Leaves at Different Districts of Alexandria Governorate

[1]Ezz, Thanaa. M., [2]B. M. Weheda, [1]M. K. Gaber and [2]A. S. Abd El-Aziz
[1]Plant Production Dept. Faculty of Agriculture (Saba Basha) Alexandria University
[2]Hort. Res. Inst., Agricultural Research Center, Alexandria, Egypt
Corresponding author- email: nour_flowerm@yahoo.com

ABSTRACT:

The present study was carried out during four seasons of Winter, Spring, Summer and Autumn (2016). Three different districts were chosen to identify the occurring pollution and levels of detected pollutants. These districts were (El-Montazaha, East-district and El-Amereya) districts. In each one, two areas were selected to determine the degree of prevailing pollutions; one of them resembled heavy polluted area (from factories/ exhaust car parks-etc..,) and the other far from pollution resources, i.e less polluted area. Whereas from El-Montazaha district; El-Montazaha garden and Abokeir fertilizers factory from East district, El- Shallalat garden and some surrounding, streets; and from Amereya district a Portoland cement factory and a public garden, were chosen for this performed study. In each of these investigated sites, the similar trees of *Ficus nitida* were used for detecting the level of occurred pollution, in particular the leaves of this trees could be regard and use as promising clean up technology for variety of accumulating heavy metals (Lead, Cadmium, Nickel, Copper and Zinc) and reduce the environmental pollution. The experiments were carried out in a split- split plot design with three replicates. Districts (El-Montazaha, East-district and El-Amereya) were arranged in the main plots, Locations (low and high polluted areas) were arranged in sub plots and Seasons (winter, spring, summer and Autumn) were arranged in sub-sub plots. The data collected were analyzed using analysis of variance (ANOVA) with the aid of SAS and significant means were separated using Least Significant Difference (LSD) at 5% probability level. The results of the study found that El- Montazaha garden was the least area contaminated with heavy elements, followed by El- Shallalat garden and then the garden of Amereya.

Key words: leaf characteristics, Pollution, garden, Locations, districts, Heavy metals. *Ficus nitida* L., NPK.

INTRODUCTION

Pollution is defined as an undesirable change in physical, chemical and biological characteristics of air, water and land which is harmful to living organisms, living conditions and cultural assets, of an environment. unfavorable alteration of our surrounding, mainly due to human activities or natural ecosystems, Ramesh *et al*. (2013). The substances, which cause pollution, are called pollutants. Pollutant is defined as any substance that is released intentionally or inadvertently by man into the environment in such a concentration that may have adverse effect on environmental health. Environment Protection defines pollutant, as any solid, liquid or gaseous substance present in such a concentration as may be, or tend to be, injurious to environment. (Moore ,1994).

Pollution occur when enough of a substance is present in the environment at concentrations causing harmful effects on human health, physiology, growth and yield of vegetative; the quality of horticulture and ornamental plants and corrosion of buildings, Increasing in gaseous air pollution over recent decades have been experienced in many industrial and urban centers in developing countries, primarily as a result of rapid economic growth, urbanization, industrialization with associated increases in energy demands (Emberson *et al*., 2001). These have inevitably led to a series of environment-related problems, not the least of which is worsening air quality (WHO /UNEP, 1992).

Heavy metals make a significant contribution to environmental pollution as a result of human activities such as mining, smelting, electroplating, energy and fuel production, power transformation, intensive agriculture, sludge dumping, and military operations (Jung, 2001).

Heavy metals may be retained in the soil as exchangeable metals, carbonates, hydroxides, Fe/Mn oxides, or may be bound to organic matter. It is important to know how the heavy metals are held in the contaminated soil before designing a remediation process (Tessier,1979).

However, it can be contaminated with heavy metals if it grows in contaminated soils and water. The high concentration of heavy metals in soils is reflected by higher concentrations of metals in plants. The ability of some plants to absorb and accumulate toxins makes them useful as indicators of environmental pollution (Subramanian *et al.,* 2012).

Heavy metals are one of the important types of contaminants that can be found in the surface and in the tissue of fresh vegetables. Heavy metals such as cadmium, copper and lead, are important environmental pollutant can cause environmental hazards and are reported to be exceptionally toxic (Nadine Al-Chaarani *et al.,* 2009; Abdul-Wahab *et al*., 2009).

Lead is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield Uwah and Ogugbuaja 2012; Hamid Iqbal *et al.,* 2013).

Reports indicate that lead, cadmium and arsenic may cause a wide variety of changes in biological systems, even at very low concentrations. Leaf area index is an important essential biodiversity variable due to its role in many terrestrial ecosystem processes such as evapotranspiration, energy balance, and gas exchanges as well as plant growth potential. The leaf area is lower in trees growing in the polluted area than those of control one. Significant difference ($P<0.05$) was recorded in between and reached its maximum value in the polluted leaf samples as compared with those of control. (El-Khatib *et al.,* 2004).

Chlorophyll is the principal photoreceptor in photosynthesis, the light-driven process in which carbon dioxide is “fixed” to yield carbohydrates and oxygen. When plants are exposed to the environmental pollution above the normal physiologically acceptable range, photosynthesis gets inactivated. (Ong and Tee, 1992). Ribulose-1,5-bisphosphate carboxylase / oxygenase is a bifunctional enzyme which catalyzes two competing reactions, photosynthetic CO_2 assimilation and photorespiratory carbon oxidation in the stroma of the chloroplasts and is the most abundant protein in leaves, Environmental stress factors can cause reversible and irreversible inactivation of Rubisco. The plants can be used as both passive bio monitors and biomitigators in the urban-industrial environment to indicate the environmental quality and to ameliorate the pollution level in a locality (Backett *et al.*, 1998).

The aim of this study was to evaluate the environmental risk caused by some heavy metals (lead, cadmium, nickel, copper and zinc) on characteristics and elemental composition of *Ficus nitida* tree leaves at different districts of Alexandria governorate. This environmental risk assessment is bared on the total element content of the selected potentially toxic elements and their comparison with environmental standard for single evaluated compartments.

MATERIALS AND METHODS

The present work was carried out during four seasons of Winter, Spring, Summer and Autumn (2016). Three different districts were chosen to identify the occurring pollution and levels of detected pollutants. These districts were (El-Montazaha, Est-district and El-Amereya) district. In each one, two areas were selected to determine the degree of prevailing pollution; one of them resembled heavy polluted area (from factories/ exhaust car parks-etc..,) and the other far from pollution resources, i. e less polluted area. Whereas from El-Montazaha district; El-Montazaha garden and Abokeir fertilizers factory from East district, El- Shallalat garden and some surrounding, streets; and from Amereya district a Portoland cement factory and a public garden, were chosen for this performed study. Soil samples from each area were collected, dried and crushed to pass through 2 mm plastic sieve and stored in plastic containers for routine laboratory analysis.

The selected properties of the soil including the tested heavy metals are listed in (Table 1). In each of these investigated sites, similar trees of *Ficus nitida* were used for detecting the level of occurred pollution, in particular the leaves of this tree could be regard and use as promising clean up technology for variety of accumulating heavy metals (Lead, Cadmium, Nickel, Copper and Zinc) and reduce the environmental pollution.

Some physical and chemical characteristics of the experimental soil are given in Table (1) the soil was analyzed according to the methods described by Page *et al.* (1982).

Randomly leaf samples of *Ficus nitida* were collected from each of *Ficus nitida* trees in the inspected area, throughout four subsequent seasons (winter-spring- summer and autumn). Samples of collected 20 leaves per tree at a height of 2-3 meter from the soil surface were used for performed chemical analysis for estimating the degree of occurring pollution. The level of comparison between in inspected pollution in the sites of garden and factories, was made by means of the obtained results. The followed experimental design was split-split plot with three replications.

Table (1). Basic properties of the contaminated soil samples

	Sample analysis					
A) Chemical properties	**El-Montazaha garden**	**Abokeir fertilizers factory**	**El- Shallalat garden**	**El- Shallalat (Bab-shark areas)**	**Factory garden**	**Amereya Portoland factory**
pH (1: 1)	٧.٨0	7.٩0	8.00	8.00	٧.٨٠	7.٧0
EC (dS/m)	0.75	6.30	4.40	3.20	3.20	1.60
$CaCO_3$ %	32.46	10.32	23.81	20.75	32.46	20.56
S.P. %	33.33	37.5	48.31	40.26	25.86	26.66
1)Soluble cations						
K^+ (mg/l)	0.28	1.92	0.7	0.9	1.52	1.12
Ca^{++} (mg/l)	2	32.50	15	18	17	27.5
Mg^{++} (mg/l)	0.50	11	8	12	2.50	4.5
Na^+ (mg/l)	5	26	13	17	18	5
2)Soluble anions						
HCO_3^- (mg/l)	5	9.50	16.50	12	11.50	7.50
Cl^- (mg/l)	2.50	27.50	23.60	20.50	17.50	3.75
SO_4^{--} (mg/l)	0.28	34.42	3	5	2.62	6.87
CO_3^- (mg/l)	1	----	----	----	----	----
3)Total heavy metals						
Pb mg/kg	134.70	838.21	1307.96	3493.43	411.96	1610.94
Cd mg/kg	0.087	5.87	4.89	7.02	7.98	9.22
Ni mg/kg	51.63	61.39	64.81	76.46	80.44	93.88
Cu mg/kg	88.341	125.23	95.42	155.66	213.46	247.68
Zn mg/kg	170.42	310.45	208.79	322.45	349.03	379.04

The suitability of soils for agricultural uses could be assessed by using pollution index which assesses the environmental risk. The pollution index can be estimated by using the following formula (Li *et al*., 2003)

$$Pi = \frac{Ci}{Si}$$

Were *Pi* is an environmental quality index for heavy metal I; *Ci* is the heavy metal content in a soil sample (mg/kg); *Si* is the permitted standard of the same metal (mg/kg) Table (2).

Where *Pi* > 1, the soil sample is classified to be polluted, while *Pi* ≤ 1 suggests unpolluted soil.

Table (2). China national standards for soil environmental quality of heavy metal (G B 15612-1995) unit: mg/kg

Soil pH	Pb	Cd	Cu	Ni	Zn
<6.5	250	0.3	50	40	200
6.5-7.0	300	0.3	100	50	250
>7.5	**350**	**0.6**	**100**	**60**	**300**

China Environmental Quality Standard for Soils (GB15612-1995).

Studied characters: -
leaf characteristics:

- Fresh and Dry weight of leaves (g/ plant).
- Chlorophyll (chlorophyll a, b and total) (mg/ g fresh weight) were determined in fresh leaves of *Ficus nitida* trees, chlorophyll was extracted by acetone (Dawood, (1993).
- Leaf area (cm^2) by taking a constant number of 20 discs for each replicated tree. Then the relationship between the fresh weight of these discs and their area was calculated according to (Zidan, 1962):

$$\text{Leaf area } (cm^2) = \frac{\text{Leaf weight x square areas}}{\text{Square weight}}$$

- **Total heavy metal measurements (Pb, Cd, Ni, Cu and Zn)**

Total concentrations of the tested heavy metals (Pb, Cd, Ni, Cu and Zn) were determined by wet digestion of soil according to Page *et al.,* (1982). 1 g of collected surface soils were weighed and placed in a Teflon plastic crucible. 5 ml HNO_3, 10 ml HF and 12 ml $HClO_4$ were added into soils and oscillated for 10 h under constant temperature (80ºC). When the samples were almost dried, 10 ml nitric acid (1:1) was added to dissolve the samples continually. The dissolved soil samples were transferred constantly to 50 ml volumetric flask to determine the total contents of tested metals in soils.

Statistical analysis

All the collected data were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The treatment means were compared using L.S.D. test at 0.05 level of significant.

RESULTS AND DISCUSSIONS

Assessment of soil contamination

The results obtained in Table (1) were assessed according the data in Table (2). The Abokeir fertilizers factory - El- Shallalat (Babshark area) and Amereya Portland factory were found to be higher polluted by heavy elements (Pb, Cd, Ni, Cu and Zn). El-Montazaha garden area was found to be non-polluted (Table 3).

Leaf characteristics of *Ficus nitida* in high and low polluted areas:

Results presented in Table (4) showed the estimated values of leaf characteristics of growing *Ficus nitida* trees (leaf area, fresh weight and dry weight) in the high and low polluted locations in the studied Alexandria districts. leaf characteristics were higher during the winter and autumn seasons, than the spring and summer ones.

Table (3). Pollution index (Pi) for heavy metals of different districts of Alexandria

Elements heavy metals	El-Montazaha garden	Abokeir fertilizers factory	El- Shallalat garden	El- Shallalat (Babshark areas)	Factory garden	Amereya Portoland factory
Pb mg/kg	0.38	2.394	3.73	9.981	1.17	4.60
Cd mg/kg	0.145	9.78	8.15	11.7	13.3	15.36
Ni mg/kg	0.86	1.02	1.08	1.27	1.340	1.56
Cu mg/kg	0.88	1.25	0.95	1.55	2.13	2.47
Zn mg/kg	0.56	1.03	0.69	1.07	1.16	1.26

In general, leaf area from trees of El- Montazaha district. (29.69 cm^2) has significantly higher value than that of EL-Amereya district which gave the least value of (17.14 cm^2).

This result agrees with those of (Byers *et al.,*1992). who recorded that pollutant effects are responsible of the decrease in leaf area.

The significance of the calculated data was determined for the effects of districts, locations and seasons on the estimated values of fresh, dry weights of leaves of *Ficus nitida* trees. Results showed a relationship between the extracted values of fresh and dry weights which amounted to 16.33 (g.) for fresh weight and 5.26 (g.) for dry weight in El-Montazaha district, against 12.03 (g.) for fresh weight and 2.67 (g.) for dry weight in EL-Amereya district, Table (4).

Table (4). Effect of different districts, locations and seasons on leaf characteristics of *Ficus nitida* at high and low polluted areas during 2016 season.

Treatment	Leaf area(cm^2)	Fresh weight(g)	Dry weight(g)
Districts			
El-Montazaha	29.69a	16.33a	5.26a
East-district	24.69b	13.72b	3.21b
El-Amereya	17.14c	12.03c	2.67c
L.S. $D_{0.05}$	**0.61**	**0.14**	**0.176**
B) Locations			
Low polluted area	25.02a	16.64a	5.19a
High polluted area	22.14b	13.06b	2.90b
L.S. $D_{0.05}$	**0.50**	**0.114**	**0.144**
C) Seasons			
Winter	23.318b	13.760b	3.211a
Spring	20.308d	12.461d	2.867b
Summer	21.677c	12.882c	2.941b
Autumn	25.002a	14.356a	3.186a
L.S. $D_{0.05}$	**0.563**	**0.2177**	**0.121**
Interaction			
AXB	**	**	**
AXC	**	**	**
BXC	ns	ns	**
AXBXC	**	ns	ns

Means of each factor designated by the same letter not significantly different at 5% using least significant difference (L.S.D.)
ns: not significant
*: significant at 0.05 level of probability.
**: significant at 0.01 level of probability.

Table (5) showed the estimated values of Chlorophyll A, B and total Chlorophyll of *Ficus nitida* trees in the upper polluted and lower polluted locations in the studied Alexandria districts. It revealed that data of Chlorophyll A, B and total Chlorophyll at El- Montazaha district. (0.891, 0.614, 1.505 mg /g F. W), respectively was significantly higher than that of EL-Amereya district with values of 0.556, 0.333, 0.889 mg /g F. W respectively. Chlorophyll content was higher during the winter and autumn seasons, than the spring and summer ones.

These results agree with those of Nirbhay (2017) who showed significant drop in chlorophyll content of leaves growing in polluted area because of the reduction of photosynthetic activity and thereby reduction in the

chlorophyll content. Ratio had extremely low values in case of plants growing in higher polluted area when compared with those from lower polluted area.

Table (5). Effect of different districts, locations and seasons on Chlorophyll (A. B. Total) *Ficus nitida* at high and low polluted areas during 2016 Seasons.

Treatment	Chlorophyll A (mg/g f. w)	Chlorophyll B (mg/g f. w)	Total Chlorophyll (mg/g f. w)
B) Districts			
El-Montazaha	0.891a	0.614a	1.505a
East-district	0.699b	0.419b	1.062b
El-Amereya	0.556c	0.333c	0.889c
L.S. $D_{0.05}$	**0.0005**	**0.0011**	**0.114**
B) Locations			
Low polluted area	0.864a	0498a	1.362a
High polluted area	0.633b	0.379b	1.013b
L.S. $D_{0.05}$	**0.0004**	**0.001**	**0.092**
D) Seasons			
Winter	1.170a	0.467a	0.776a
Spring	0.992b	0.372c	0.620c
Summer	0.797c	0.298d	0.498d
Autumn	1.116a	0.418b	0.698b
L.S. $D_{0.05}$	**0.108**	**0.0015**	**0.002**
Interaction			
AXB	**	**	**
AXC	**	**	ns
BXC	**	**	ns
AXBXC	**	**	ns

Means of each factor designated by the same letter not significantly different at 5% using least significant difference (L.S.D.)
ns: Not Significant
**: significant at 0.01 level of probability.

REFERNCES

Abdul-Wahab, O., El-Rjoob Mohammad and N. Omari (2009). Heavy metals contamination in *Malva Parviflora* L.(Malvaceae) grown in soils near the Irbid-Amman Highway. J. Int. Environm. Appli. and Sci., 4:433-441.

Backett, K. P.; P. H. Free-smith and G. Taylor (1998). "Urban woodlands: Their role in reducing the effect of particulate pollution" Environmental Pollution, 99: 347–306.

Byres, D. P.; T. J. Dean and J. D. Johson (1992). Long term effects of ozone and stimulated acid rain on the foliage dynamics of slash pine. (Pinus ellioti var. ellioti. Englem). New Phytol. ,120: 61-67.

Chapman, H. D. and P. F. Pratt (1978). Method of Analysis for Soil and Water. 2nd Ed., Chapter, 17pp 150-161. Uni. Calif. Div. Agric. Sci. USA.

Dawood, H. G. (1993). Chemical Properties and Analysis, Chlorophll.in Cyclopedia of Food Sci. and Nutrition (B. Caballero. Ed) Academic Press. London:904-910

El-Khatib, A. A., F.A. Faheed, and M. M. Azooz (2004). physiological response of Eucalypuse -rostrata to heavy metals air pollution. El-Minia Science Bulletin, Egypt, 15: 429-451.

Emberson, L., M. Ashorore, L. De temmerman, and P. Williams (2001). Air pollution and vegetation. Environ. Pollut.,98 (2): 111 -119.

Gomez, A. K. and A. A. Gomez (1984). Statistical procedures for Agricultural Research. (2nd edition). John Wiley and Sons. New York.

Hamid Iqbal, B. Khattak, S. Ayaz, A. Rehman, M. Ishfaq and M. N. Abbas (2013). Pollution based study of heavy metals in medicinal plants *aloe vera* and *tamarix aphylla*, J. Appl. Pharm. Sci., 3:054-058.

Jackson, M. L. (1973). Soil chemical analysis, Prentice Hall of India private limited, New Delhi, P. 498.

Jung, M. C. (2001). Heavy metal contamination of soil and waters in and around the Imcheon Au-Ag mune, Korea. Applied Geochemistry, 16:1369-1375.

Li, J., Z. M. Xie and J. M. Xu (2003). Evaluation on environmental quality of heavy metals in vegetable plantation soils in the suburb of Hangzhou [J]. Ecology and Environment, 12(3): 277-280.

Lindsay, W. L. and W. A. Norvell (1978). Development of DTPA soil test for Zn, iron, manganese, and Copper. Soil. Sci. Soc. Am. J. 42:421-428.

Lowther, G. R. (1980). Using of a single H_2So_4 - H_2O_2 digest for the analysis of Pinus radiate needles. Commun. Soil Sci. Pl. Analysis, 11: 175-188.

Moore, C. (1994). Urban Air pollution in H. Cincotta (Ed). Green paper series (Beacon Publishers) pp.1-15.

Nadine A., J. H. El-Nakat, P. J. Obeid and S. Aouad (2009). Measurement of levels of heavy metal contamination in vegetables grown and sold in selected areas in lebanon, Jordan. J. Chem., 4:303-3015.

Nirbhay, S. P. (2017). Adverse Effect of Air Pollutants on the Chlorophyll Content in Leaves from Pune, Maharashtra (India) Int. J. Pharm. Sci. Rev. Res., 44(2),26:131-135

Ong, A. H. and E. S. Tee (1992). “Natural sources of Carotenoids from plants and oils”, Meth. Enzymol, 213: 142-167.

Page, A. L.; R. H. Miller and D. R. Keeny (1982). Methods of soil analysis part 2 Amer. Soc. Agric. Inc. Madison W19:595.

Ramesh, K.; C. Anandakumar; R. Balakrishnan and D. Rajavel (2013). Use of Plant species in controlling Environmental pollution- A Review Bull. Env. Pharmacol. Life Sci., India. 2(2) January:52-63.

Subramanian, R., S. Gayathr, C. Rathnavel and V. Raj (2012). Analysis of mineral and heavy metals in some medicinal plants collected from local market, Asian Pacific J. Trop. Biomed., S74-S78

Tessieer A.; P. G. C. Campbll and M. Bisson (1979). Sequenntial extraction procedure for the speciation of particulate trace metal. Analytical Chemistry, 51:844-850.

Uwah, E. I. and V.O. Ogugbuaja (2012). Investigation of some Heavy Metals in Citrullus vulgaris, Cucumis sativus and Soils obtained from Gardens being Irrigated with Wastewater in Maiduguri, Nigeria, Global Res. J. Agric. and Biolog. Sci., 3: b373-380.

WHO/UNEP (1992). Urban Air Pollution in Megacities in the World. World Health Organization/United Nation Environmental Programme,Black Well,Oxford, UK.

Zidan, E. (1962). Evaluation of Some Tomato Lines in Regard to leaf Area and Leaf Efficiency and Relation of Partial detection to Early and Total Yield, Fruit Size, Soluble Solids, leaf Rolling and Blossomed. Ph. D. Thesis, Cornel Univ. Hacha- N.Y., U.S.A.

الملخص العربي

تقييم التربة الملوثة بالعناصر الثقيلة وعلاقة ذلك بخصائص ومحتوى العناصر لأوراق أشجار الفيكس نتدا النامية في بعض أحياء محافظة الإسكندرية

[١] ثناء مصطفى درويش عز [٢] بثينة محمد لبيب وحيدة [١]محمد قدري عبد الحفيظ جابر
[٢]عائشة سعيد عبد العزيز إبراهيم
[١]قسم الإنتاج النباتي– كلية الزراعة (سابا باشا)– جامعة الأسكندرية
[٢] قسم بحوث الزينة وتنسيق الحدائق – معهد بحوث البساتين – مركز البحوث الزراعية

أجريت التجربة فى ثلاثة أحياء(حى المنتزة –حى باب شرق– حى العامرية) تم إختيار منطقتين من كل حى لتحديد درجة التلوث الموجودة سواء عوادم سيارات ، أدخنة المصانع أو غيرها فتم إختيار حديقة المنتزة كمنطقة خالية من التلوث ، شركة أبو قير للأسمدة من حى المنتزة كمنطقة ملوثة ،ومن حى باب شرق إختيار حديقة الشلالات من الداخل كمنطقة قليلة التلوث وحديقة الشلالات من الجهة المطلة على شارع أبو قير كمنطقة ملوثة ، وإيضا إختيار حديقة الشركات بحى العامرية كمنطقة قليلة التلوث وشركة أسمنت العامرية بورتلاند كمنطقة ملوثة. وإجريت الدراسة على أشجار فيكس نتدا لتقدير مستوى التلوث وتأثيره على مساحة الورقة ، الوزن الطازج والجاف للأوراق وقياس نسبة الكلورافيل (ا) ،(ب) والكلورافيل الكلىَ وعلاقة ذلك بالأحياء والمناطق والمواسم الإربعة ((شتاء –ربيع– صيف– خريف) خلال عام ٢٠١٦

أوضحت النتائج حدوث زيادة فى مساحة الأوراق ونسبة الكلورافيل والوزن الطازج والجاف للأوراق فى المناطق قليلة التلوث وكانت أعلى القيم فى حديقة المنتزة الأقل تلوثاَ مقارنة بحى العامرية الأكثر تلوثاَ.