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Phytoremediation of Lead (Pb) Metal in Contaminated Soils of some locations in Baghdad City

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Abstract : Mechanisms phytoremediation of Lead metal from contaminated soil are a little time consuming because metals cannot degrade, therefore effective cleanup requires to reduce or remove toxicity, use of plants to remove, detoxify or immobilize environmental contaminants in a growth matrix in soil through the natural, biological, chemical or physical activities or processes of some location in Baghdad city , the current study was conducted to determine the effects of soil pollution and the plant absorption of pollutants and their effects on the population in parks. In the city of Baghdad, where ten areas were identified (5 areas by Karkh - 5 areas of the Rusafa side with control), pH and soil texture were measured and element concentrations (Pb) through the average results of plants that have been obtained there is a relationship between plants with a difference from one to other depending on the ability to absorb Lead and content in three dominate plants species, Consecutively: *Cynodon dactylon*> *Eucalyptus camaldulensis*> *Dodonea viscosa*, (0.033, 0.032. 0.018) ppm Respectively. Lead compounds can be dissolved in water which may result in introduction to soil and thus transfer to food chain. Many industrial activities such as mining, processing minerals and chemical industries, increase non-essential metal concentration in the water tables in the surrounding regions of their manufacturing plants.
Keywords : Phytoremediation of Lead (Pb) Metal, Baghdad City.

Introduction

There has been a concern and increasing the accumulation of metals in the environment this is due to unlike many materials such as metals are not biodegradable and accumulate in the environment. Several metals cause pollution 'Mercury, Iron, Zinc, Arsenic lead, cadmium and chromium enter the environment by industrial waste[1]. At present attempts making to remediate the environmental elements with conventional remediation new technologies such as soil flushing , stabilization and solidification , electro kinetics chemical reduction and oxidation, low temperature thermal desorption, soil washing incineration and verification, excavation and retrieval, fracturing pneumatic and landfill disposal, these are expensive thus the potential role of bioremediation, particularly by higher plants has gained considerable attention. Higher plants accumulated metals in different concentrations and significantly between plants and soil surrounding it[2].

Pollution considers are substance inters the natural environment as a result of human activities and in quantities sufficient to produce change and undesirable effects[3]. The soil always responding to any changes in environmental factors some of these changes in the soil will be of short duration and can be reversible off-hand, others will be permanent in soil causes the reduction in the productivity[4]. Soils polluted by heavy metals, therefore, the plants growing on these soils show yield, reduction in growth and performance[5] and effect on the physical, chemical and biological properties of the soil such as; Fertilizers, Pesticides, organic manure, leather goods, radioactive wastes, discarded food, plastics, and acid rain all contribute towards causing soil pollution. Several studies used of wastewater contaminated with heavy metals for irrigation above the permissible limit[6].

Heavy metals are either in combination with other soil components or separate entities[7]. Plants require heavy metal for their growth but the excessive amounts of metals can become toxic plants, the negative impact of heavy metals has on the activities and growth of soil and affects the growth of plants as a reduction in soil nutrients. Plants have the capacity to resist comparatively of a high concentration of elements contaminants. Some of it at low concentration as essential micronutrients for plants, but in higher concentration may cause growth inhabitation[8]. Many researchers have observed that plants such as Corn (Zea mays L.) Indian mustard (Brassica juncea), sunflower (Helianthus annuls L.) found a high tolerance to heavy metals and used in phytoremediation studies[9]. Several studies have been conducted on the phytoremediation of perennial plants, such as Eucalyptus camadulensis , High concentrations of lead(Pb) above-ground parts (shoots) and also has a great ability to dissolve the metal in the soil in the 15 mg/kg thats mean this plant can be a suitable plant for phytoremeadtion[10]. Other studied conducted have been Cynodon dactylon accumulate high concentrations of Pb[11] To understand the concept Phytoremediation with important goals that identify the changes that had happened in the environment of the area in Baghdad city are:

1- Determination of the concentrations of some heavy elements represented (Pb) in the Plants and soil in study areas.

2-Evaluate the plants in which the respective heavy metals are stored and determine the translocation of the metals from soil to plant.

Materials and Methods:

Sampling

Eleven basic stations were chosen in this study of Baghdad province between the sides of Karkh and Rusafa with control, of each area were labeled it depending coordinates these locations were determined by the (GPS/ Geko 201, Taiwan).

1- Environmental Samples: Soil Samples were collected by using cleaned polyethylene bags from 10 cm in depth.

2- Biological Samples: Plants were surveyed this area and selected most common plants**,** collected in cleaned polyethylene bags. Three basic species of plants were chosen *Eucalyptus camaldulensis, Dodonaea viscosa, Cynodon dactylon.*

Plants samples were collected and then rinsed thoroughly with deionized water and dried in the outdoor in room temperature for (3-5) days then ground with an agate mortar to be ready before analysis, selected with surrounding soil for each plant type from the same area, and collected a one sample of soil far the plants as the same area, becomes the total samples three types plants, three soil surrounding it as well as soil far from the plants (Three plants, Four soil for one area).

Preparing Experimental and Analysis:

Determination of Elements by Atomic spectrometer contra 700 type and has been examined in the Ministry of Commerce/General Company for Foodstuff Trading / quality control division. This method of analysis that used to identify the concentrations of elements and trace elements in the various kinds, the material to be measured must be liquid, hence must be converted the solids samples to solutions by specific method of regulation and melting and used method validation was used as reference material with preparation of samples for analysis by Top wave analytic Jena type. All types were collected by weight 50 mg into the digestion vessel, add 5ml of nitric acid HNO3 %65 after that the mixture was shaken carefully or stirred with clean glass bar necessary and wait at least (20 min) before the vessel is closed, Heated in the Microwave oven with the following program to avoid foaming and splashing wait until the vessels have cooled the same room temperature about (20 min). The digestion vessel was carefully opened in fume hood wearing hand Eye and body protection since a large amount of gas would be produced during the digestion process, then they were quantitatively transferred to Falcon tubes and diluted to 15 ml with deionized water. For the quality control analysis, 0.250 g were transferred into a Teflon vessel, reconstituted with 2 mL of deionized water, followed by the addition of 4 ml of HNO3. For all samples digestions, five replicates were performed, calibration blanks of 2.0 mL deionized water were taken through the same digestion process. Detection limits for heavy metals in this study were calculated based on three times the standard deviation of the average of 5 blank measurements to one test depending methods[12].

A-PH: Measure the pH values of a suspended solution from the soil with the pH meter. Prepare the suspended solution from the soil by taking 50 g of the sample of the previously dehydrated and dehydrated soil. Add 50 mL distilled water. Mix the solution well and leave for 30 minutes stirring every few minutes. After leaving the solution suspended for a full hour, after the expiration of the full hour was well blended (Icarda, 2001).

B- Soil Texture: Hydrometer method was used to measure the content of silt and clay according to (Icarda, 2001). The soil size of the soil was dehydrated and precipitated. The size distribution of the soil components was generally determined for the sand particles (0.05-2mm), the clay particles (0.002-0.05mm) and clay particles (0.002mm <). Solutions used prepare to dissolve (40 g) of Sodium hexametaphosphate (Na Po3) 13 and (10 g) of Sodium carbonate (Na2Co3) in distilled water, and complete the volume to 1 liter with distilled water and the method of work to take the weight (40 g) of the soil,, 60 mL of solution A was added, and the solution was left after 24 hours of coverage, then placed in the blender Distilled water was added to about three quarters the size of the blender cup, blending for 3 minutes Then take the resulting suspension solution and leave for 1 minute, then transfer to a liter of hydrometer cylinder and complete the volume with distilled water .

C: Silt and Clay: The suspended solution was mixed in the hydrometer cylinder and immediately after the hydrometer was immersed, and the reading was recorded after 40 seconds. Reading (Rsc) to estimate the Blanc solution: (60 ml) of solution A was added to the hydrometer cylinder and completed with distilled water to (1 liter) and then recorded reading (Rb) (Clay + silt) % = (Rsk-Rb) X 100 / dry soil weight).

Clay:
Mix the suspended solution in the hydrometer cylinder and let it settle down. After about 4 hours, the reading (Rc) is taken. (Alarabi, 2017)

Clay% = (Rc-Rb) X 100 / dry soil weight
(silt + clay) % - clay (%). Silt % =

D: Sand:
Take the suspended solution and pass through a sieve (50 micrometers) and then transfer the sand to a pre-weighed container. Leave the sand in the pot. Then remove the excess water, drain it at 105 ° C for a full day, cool in the desiccator and take it again with the container) Sand% = Weight of sand X 100 / Dry soil weight. (Alarabi, 2017) After recording all the results of sand, silt and mud percentages, soil tissue was determined using a soil tissue triangle.

3.6: Statistical method:

The statistical analysis was performed according Sigma. It was assessed by using different measures of statistical coefficient of determination, concordance correlation coefficient and interclass correlation coefficient, mean prediction error the concentration is compared with the data from their label and proposed guidelines published by WHO / USEPA under the Principal Components Analysis of elements Normality Test (Henze-Zinkler), Normality Test (Shapiro-Wilk and Mann-Whitney Rank Sum Test). The coefficient of determination, r2, was calculated N is the total number of paired observations. A value of r2 = 1 indicates 100% precision between the methods to determine overall. The mean prediction error (Pe) was computed to describe the predictive performance of the methods and to compare prediction methods to the standard method. Data plotting method by used to analyses the agreement between the standard methods and according WHO and USEPA.

Results and Discussion:

Physical Properties of Soil:

PH:

The results showed that the PH values for all the studied soils samples were alkaline and ranged between (7.35-7.80) and an average of (7.66) Fig (1) and Table (1) showing PH concentrations in the study areas. This finding is similar to (Madrid *et al*, 2002), where the pH of the soil of the city gardens (Seville) is between 7.3-8.0 and also close to that when it was found that the pH To irrigate the Erbil Gardens ranges between (7.26-8.23) that the high values of pH of urban soil is due to the high percentage of carbonates, ash and waste resulting from activity[13], where it was found that in the soils, heavy metals bind with carbonates and this restricts their movement as well as alkaline components in the atmosphere that can be deposited[14]. In soil soils, higher uptake of heavy metals occurs due to an increase in the number of negatively charged soil particles, which leads to slow or determined mineral movement in the soil. Also, the high pH of the water Irrigation may contribute to increased alkalinity of soil, where some researchers reported that irrigation water leads to increased pH of the soil (HCO3), salinity and nutrients[15], where the ability of soils to restrict the movement of heavy metals increases with the elevation of the pH, under equal conditions to the base chromium is highly moving while cadmium, zinc and nickel medium to non-moving respectively. Soil acidity has a higher effect on soil solubility and mineral retention, where higher mineral retention and solubility occurs when soil pH is higher[16]

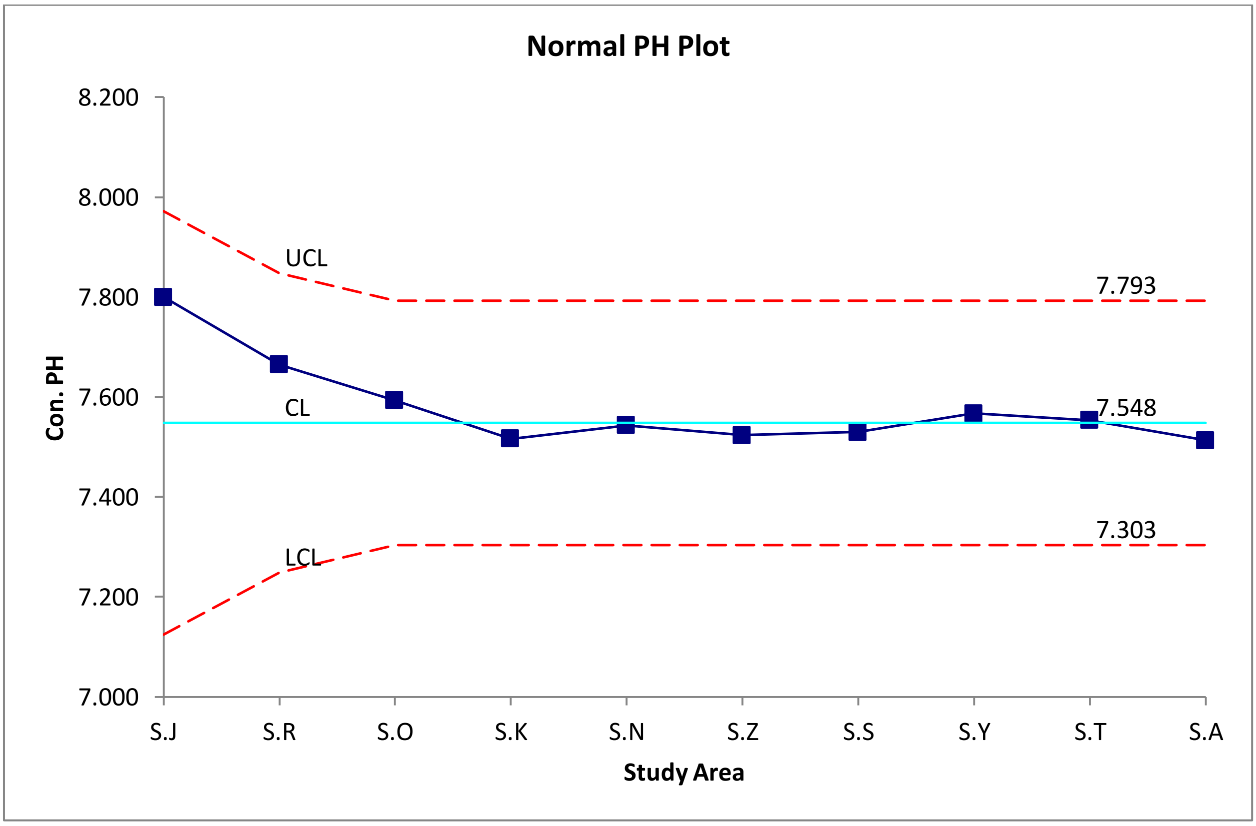


Fig (1) showing PH concentrations in the study areas

Texture Soil :

The soil granules was measured for the studied areas of the gardens of the city of Baghdad and it was found that most of the soils were Sandy Loam and as shown in Table (1)

This is due to an interaction between the size particle infractions and plays a role in the different findings in soil, the sand very important of skeleton while silt and clay particles primarily coat the surfaces of the sand grains and act as bridges between them[17]. In unsaturated soils, the parameter that determines water phase connectivity is the pore size distribution, which is in turn controlled by bulk density and particle size distribution (soil texture). Pore size and shape determine the relative magnitudes of capillary, viscous and gravitational forces, thereby controlling the water content and configuration within a pore. The location of a microhabitat in the three-dimensional pore network is of utmost importance in determining the hydrologic regime it experiences. In moist soils (e.g., those at field capacity), water films in larger pores are held by surface tension (capillary forces) in crevices on the surfaces and at the edges of pores where soil grains meet. Smaller pores in which capillary forces are stronger may be saturated at field capacity.

Table (1) Shows PH concentrations and Texture soil in the study areas

Station	PH	Sand	Clay	Loam	Texture
S.J	7.8	87.5	12.500		Sandy Loam
S.R	7.53	64	20	16	Sandy Clay Loam
S.O	7.45	77.5	22.500		Sandy Loam
S.K	7.57	71.91	28.080		Sandy Loam
S.N	7.61	28	32	40	Sandy Loam
S.Z	7.39	75	2.500		Sandy Clay Loam
S.S	7.59	65	20	15	Sandy Clay Loam
S.Y	7.72	51	24	25	Sandy Loam
S.T	7.35	47	30	23	Sandy Loam
S.A	7.47	54	25	21	Sandy Loam

Lead (Pb) Concentrations in Plants Types and Soil:

Through the average results of plants that have been obtained there is a relationship between plants with a difference from one to other depending on the ability to absorb Lead and content in three dominate plants species, Consecutively: *Cynodon dactylon*> *Eucalyptus camaldulensis*> *Dodonea viscosa*,(0.033, 0.032. 0.018) Respectively, Table (2) Shows the variation of concentration of lead in plant species, that means the variables with positive correlation coefficients and *P values* below 0.050 tend to increase together.

Table (2) shows the variation of Lead concentration in plant species

Samples	Average	SD	M	Samples	Average	SD	M	Samples	Average	SD	M
Cynodon dactylon	0.033	0.039	0.039	*Eucalyptus camaldulensis*	0.032	0.046	0.034	*Dodonea viscosa*	0.018	0.036	0.023
Soil Near the plant	0.282	0.314	0.125	Soil Near the plant	0.248	0.258	0.128	Soil Near the plant	0.383	0.416	0.2025
Soil Far the plant	0.280	0.315	0.183	Soil Far the plant	0.280	0.315	0.183	Soil Far the plant	0.280	0.316	0.183
Soil Control	0.026	0.053	0.002	Soil Control	0.026	0.053	0.002	Soil Control	0.027	0.053	0.002

In Table (3) Showed difference concentration of Lead (Pb) in soil and plants species depending on the proximity of the soil from which the plant and the soil away from it. Results were discussed and compared with the data from their label and proposed guidelines published by (UNEP, 2003). Negative correlation coefficients *P values* greater than 0.050, there is no significant relationship between the two variables soil and plants in all location P=0.425.

The plants from these sites were also characterized by high levels of Pb with soil and accumulated concentration of lead in the soil beyond when the comparison of the maximum levels with standards (Havel et al., 1989). this agree with many studied in Baghdad (Belal , 2017 ' between plants and soil (0.895 – 1.315 ppm) Respectively) and (Safaa , 2016 ; Respectively 1..2- 2.9 ppm) between plants and soil; and (Reyam , 2006. (2.06 -2.99 ppm) between plants and soil Respectively).

Table (3) Shows difference concentration of Lead (Pb) in soil and plants species

Samples	Pb1	Pb 2	Pb 3	Pb 4	Pb 5	Pb 6	Pb 7	Pb 8	Pb 9	Pb 10
Cynodon dactylon	0.068	-0.017	0.041	0.045	0.095	0.021	-0.006	-0.020	0.037	0.071
Soil Near the plant	0.136	0.075	0.087	1.082	0.359	0.319	0.094	0.083	0.114	0.477
Soil Far the plant	0.018	0.127	0.082	1.059	0.395	0.239	0.067	0.059	0.254	0.500
Soil Control	0.001	0.010	0.003	0.032	0.050	0.001	0.001	0	0	0.170
Samples	Pb1	Pb 2	Pb 3	Pb 4	Pb 5	Pb 6	Pb 7	Pb 8	Pb 9	Pb 10
Eucalyptus camaldulensis	0.051	0.019	0.046	0.049	0.117	0.022	-0.060	0.001	0.013	0.071
Soil Near the plant	0.152	0.096	0.105	0.897	0.327	0.217	0.063	0.087	0.099	0.446
Soil Far the plant	0.018	0.127	0.082	1.059	0.395	0.239	0.067	0.059	0.254	0.500
Soil Control	0.001	0.010	0.003	0.032	0.050	0.001	0.001	0	0	0.170
Samples	Pb1	Pb 2	Pb 3	Pb 4	Pb 5	Pb 6	Pb 7	Pb 8	Pb 9	Pb 10
Dodonea viscosa	0.014	-0.041	0.034	0.071	0.024	0.021	-0.025	-0.012	0.061	0.036
Soil Near the plant	0.206	0.159	0.091	0.934	1.327	0.279	0.058	0.156	0.199	0.407
Soil Far the plant	0.018	0.127	0.082	1.059	0.395	0.239	0.067	0.059	0.254	0.500
Soil Control	0.001	0.010	0.003	0.032	0.050	0.001	0.001	0	0	0.170

There is a very high concentration in the soil more than plants especially distant from soils cultivated plant. Bioconcentration Factor (BCF) in Figs (2, 3, 4) represents the ability to extract lead from the soil and plants species (Cynodon *dactylon*, *Eucalyptus camaldulensis*, *Dodonea viscosa*) respectively. BCF values of indicate movement element from the soil to the plant. Pb Metals that are accumulated by plants and largely stored in the leaf of plants greater than one indicate translocation to the aerial parts of the plant and translocation factor of each metal under investigation at the respective sites to determine the movement of lead from the roots to the aerial parts of the plant. Also Alanbari [18] reported that transport-related with soil is a major source of increased lead content in urban soils. Lead accumulation has been found to reach high levels in urban environments derived from a range of sources such as leaded gasoline. Baghdad largest industrial area electrical and petrochemical which makes it a congested area of traffic and cars that human resources may contribute to the increase of concentrations of lead in the soil where it was mentioned that deposition of lead is significantly affected by emissions of vehicles. The effect of lead on the soil environment continues for many years as it negatively affects soil components[19] .

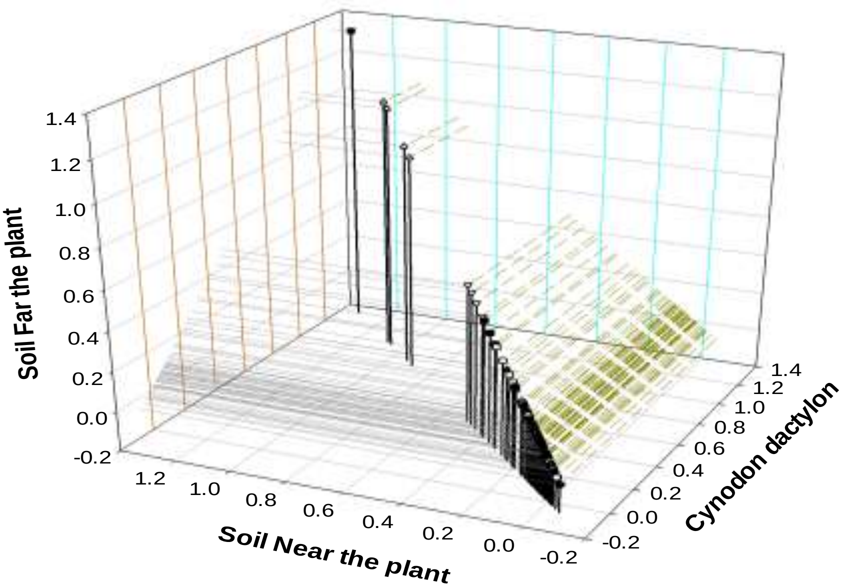


Figure (2) Comparison of Lead content in soil from *Cynodon dactylon* in all location under study area

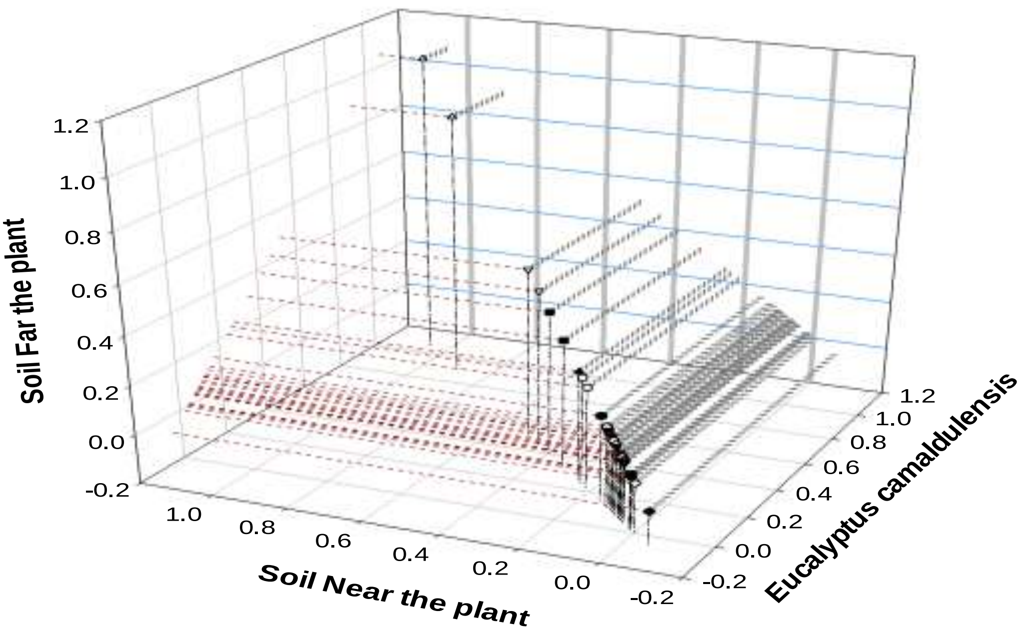


Figure (3) Comparison of Lead content in soil from *Eucalyptus camaldulensis* in all location under study area

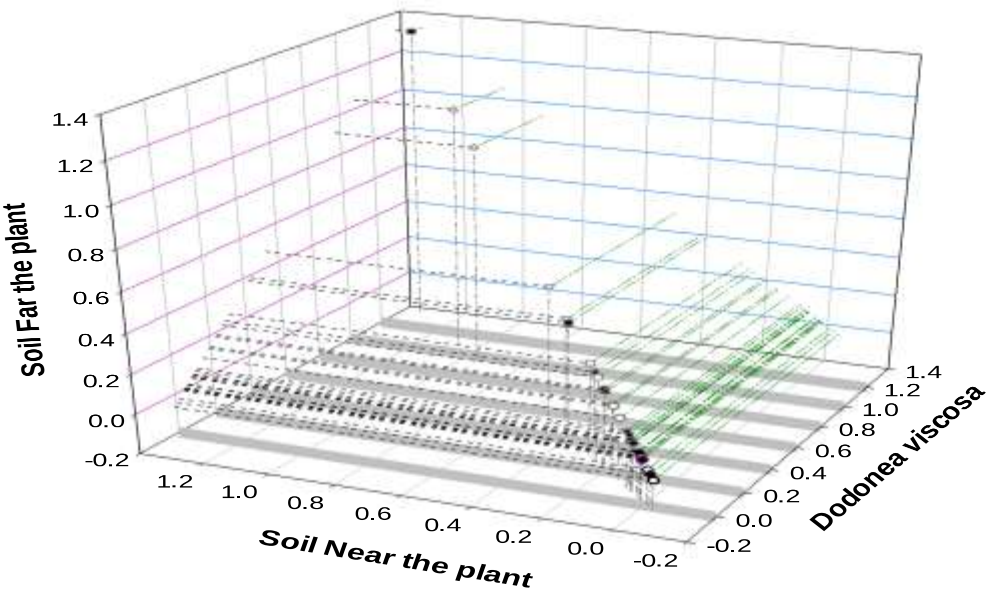
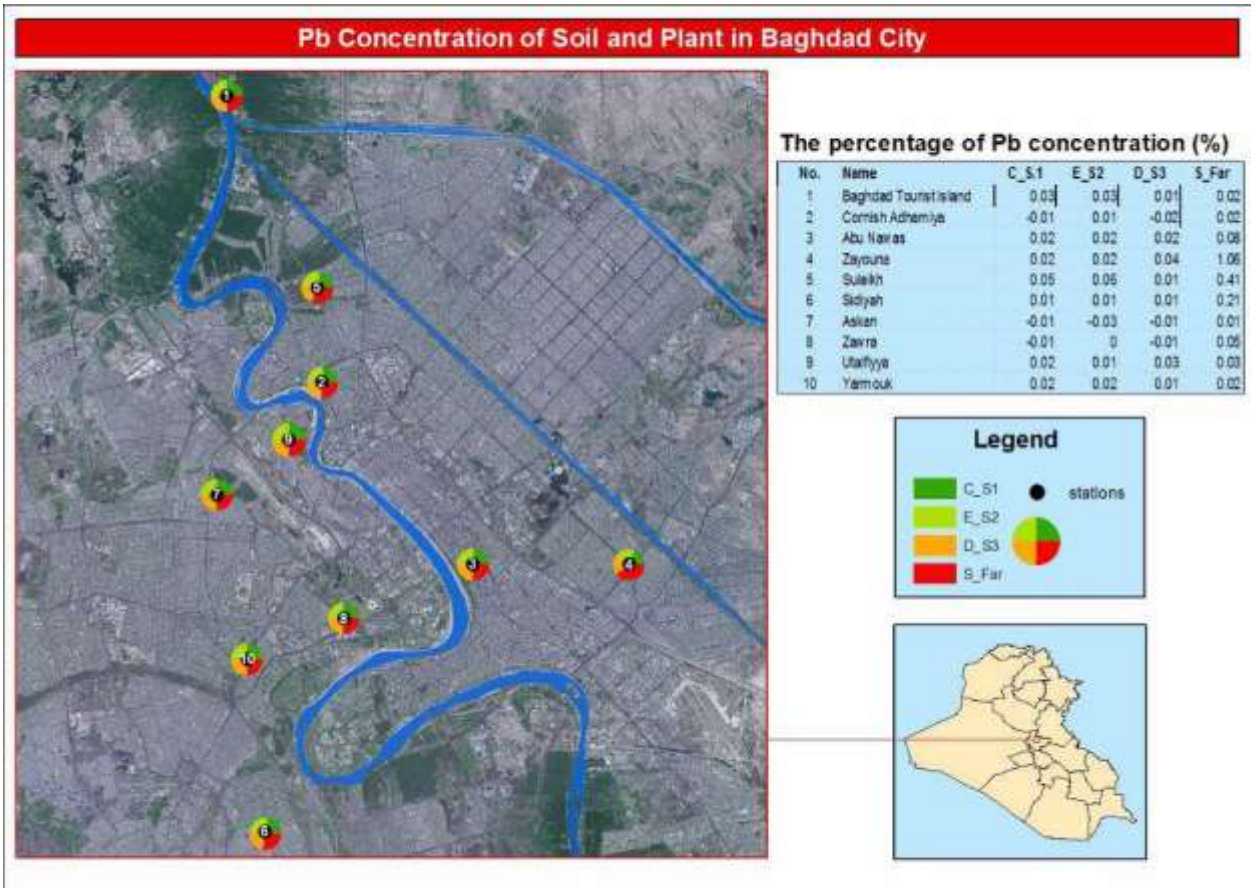


Figure (4) Comparison of Lead content in soil from *Dodonea viscosa* in all location under study area

Picture (2) describes Spatial Analysis Lead concentration in percentage relationship between the element's transfer from the soil, plant and biological treatment of this element by the plant .The resulting contour maps of Lead levels investigated in all types Plants and soil made standard deviation maps are illustrated. Depending on the type of plant, portability tolerance and absorption of lead and plants species differ from taking up accumulate various heavy metals in their tissues[20]. Lead compounds can be dissolved in water which may result in introduction to soil and thus transfer to food chain. Many industrial activities such as mining, processing minerals and chemical industries, increase non-essential metal concentration in the water tables in the surrounding regions of their manufacturing plants[21].



Picture (2): Adopted relationship for different levels of Lead (Pb) in regions under study.

Conclusion

The principal of Phytoremediation a confirming the green technology can be used to remediate elements contaminated soils. In Baghdad this technology can provide low-cost solution to remediate contaminated especially urban area. The factors that control the efficiency of Phytoremediation is such as plant species soils properties and conditions PH with Texture can used Plants to decontaminate soils contaminated with inorganic pollutants. Also the ability and tolerance these types of plants to pollution may be very important for the survival of tree species and acclimation of trees to their soil environment . Standard analytical methods Identified by using Top wave Analytic to digest sample understudied are following the legal, safety and quality standard of the world. The results showed presence of (Pb) concentration in all plants but it differs from one to another depending on the ability to absorb this element and content in three dominate plants species, Consecutively: *Cynodon dactylon*> *Eucalyptus camaldulensis*> *Dodonea viscosa*,. It was within the allowable standard limits under the study area.

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