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STUDYING THE REACTION OF LONG OAK APPLE TREES TO THE ABSORPTION OF LEAD IN THE INDUSTRIAL PARK OF RASHT

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ABSTRACT

The treatments included four stations: The fourth station was considered as the low-traffic, control station, which was located at the farthest distance from the contaminated area and factories. The three other stations were located at high-traffic and contaminated areas of the town. After that, using Tehran Municipality's Parks and Green Space Reports, and also by navigating through the streets in the industrial park, the oak apple trees were identified and selected in each station in order to make comparisons between them. The range of sampling was also adjusted so that it would be carried out during the summer. In this way, a random sampling was performed from four directions of the canopy for leaves and 15 grams of root and soil in order to measure lead absorption during the summer. The results showed that the highest concentration of lead accumulated in soil is related to station three. The lowest level of lead in the soil was related to station four, which was located at a further distance to the sources of pollution. The fourth station, which was considered as the control station, had the lowest level of lead concentration in the roots. Based on the results, the amount of lead absorbed by leaves was much higher than by roots in all stations. One of the major reasons for this is that leaves are exposed to polluted air.

Keywords: oak apple trees, lead, air pollution.

INTRODUCTION

Heavy metals are metals with a density of more than 5 grams per cubic centimeter, and the low levels of them can be found in the soil (Zahedipoor, 1996). These metals are very harmful and are considered as disturbing elements of ecosystems because of being non-biodegradable and due to their physiological effects on living organisms (Rahmani, 1995; and Dachi, *et al*., 1998). Lead is one of these heavy metals, which is important in environmental pollution by creating severe toxic effects on living organisms. The use of this metal in industries leads to its increased concentration in different ecosystems and directly or indirectly causes environmental pollution. Lead is an amphoteric metal with low electrical conductivity, and when melted in the air, it transforms into lead monoxide (Pbo) (Fazeli *et al*., 2000). Mir Ghaffari (2005) analyzed the concentration of lead in soil as well as in some plant species, such as Acantholimon sp., Noea mucronata, Scariola orientalis, Stachys inflata, and Stipa barbata around Iran Kooh mines, in order to study the application of plants in cleaning up the contaminated soils. The results indicate that Stachys inflate has the highest lead absorption with 4.582 ppm and Stipa barbata features the lowest lead absorption with 8.57 ppm. Also the lead concentration in the shoot has an inverse relationship with soil PH and a direct relationship with total concentration and soil absorption. Kruatrachue *et al*., (2006) in a study titled "uptake and accumulation of lead by plants from lead mine areas" concluded that lead accumulation is higher on the surface of soil than in soil depths. The highest concentration of lead in soil is seen in areas with vegetation and the lowest concentration of lead in soil has occurred in areas free of vegetation. On the other hand, the highest lead concentration is seen in the shoots and roots of three plant species: *Microstegium ciliatum, Polygala umbonata*, and *Sprmacoce mauritiana*. Shah Mansoori (1975), in an ecological survey of lead pollution in the River Zayanderood, found that lead concentration in the samples has a significant increase during the summer compared to the other seasons. Khadem Haghighat (1991), in a study of the distribution of lead in the sycamore leaves at traffic centers came to the conclusion that lead concentration in leaves is higher in high-traffic areas (= 61.95 ppm) than in low-traffic areas (= 5.63 ppm). Koneshloo (2006), studying the role of silviculture in restoring damaged forest ecosystems, came to the conclusion that among the species studied, Eucalyptus species have the greatest ability to absorb lead from the soil, while *Acacia* and *Dalbergia sissoo* species rank next. Kabata (2001), in his studies came to the conclusion that some soil factors like low PH and low concentrations of phosphorus in soil are considered as factors that increase the uptake of lead by plants and transferring it to the shoot. The purpose of this study was to investigate the uptake of lead in the soil, roots and leaves of the oak apple trees in various research stations in the industrial park of Rasht.

MATERIALS AND METHODS

Regarding that the pollution caused by heavy metals produced by factories in the industrial park is not the same in all areas, the sample should be indicative of the park's pollution so that different values (minimum, maximum and average) will be considered. To achieve the above objective, stations were selected from different

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areas of the town (according to the present status of plants); and after conducting the necessary tests and chemical analyses of the soil, the level of lead contamination in different parts of the park was determined. Also, the area in which contamination levels have been significantly reduced was considered as the control station to be the basis of comparison with the other areas. According to meteorological divisions, the park is located in Mediterranean warm and humid climate with an average temperature of 16.5, 1, 275 mm of rainfall and a wind speed of 2.5 meters per second. Then, using the location map of factories in the park, the *Quercus macranthera* species were identified and selected in order to make it possible for drawing comparisons between them. The range of sampling was also adjusted so that it would be carried out during the summer. In this way, the sampling took place once in August. Four stations were selected based on distance from factories and the use of factories: Pegah Milk Factory was chosen as the control station and the three other stations are located near the steel mills, Ayatollah Modarres and Qasemiran Company. Ten trees were randomly selected from each station and with a distance of 10 to 15 meters between them. From each selected tree, 15 leaves were randomly sampled from four directions of the tree canopy, 10 to 15 grams of tree root using gardening shears, as well as 10 to 15 grams of soil from a 10 to 15 cm depth. On this basis, at each site and in each season, leaf, root and soil samples for each species studied were provided using tools such as shovels, gardening shears, maps and chemicals; and then, the samples were coded and placed in paper envelopes to be transferred to the laboratory. In each species, leaf samples were carefully separated from the petiole. Also regarding the position and arrangement of leaves, the sampling was planned so that the selected leaves are from four directions of the canopy. In order to sample the surface roots from each of the species studied, some surface roots were picked from around the plant. Given that the moving of heavy metals and their compounds in the soil is limited, and also regarding that their maximum movements occur at the surface of the soil, in order to determine the levels of heavy metal that reach the soil surface from the air or rain, soil samples were taken from under (0-10 cm depth of) each tree and shrub species. The number of samples was also determined on the basis of the number of tree species, species components (leaves, roots and soil surface), the number of stations, and the sampling time point. After collecting samples and transferring them to the laboratory, the concentration of lead was measured using an atomic absorption device. One gram of soil sample, after drying and grinding, was weighed using an Aqualytic digital scale at a 0.0001 resolution, and then digested and concentrated using 50% Nitric and hydrochloric acids on an electric oven at 95°C. The samples were filtered using a Whatmanfilter paper No. 1, and a 603Perkin-Elmer atomic absorption device was used to measure the concentration of lead. In this study, a GPS device was used for identifying and implementing research stations on the map; gardening shears were used for separating branches and surface roots; a shovel for digging the soil profile; cellulose envelopes for collecting and transporting sample plants and soil; and distilled water and hydrochloric acid were used for washing plant organs. Also, data analysis was performed using Excel and SPSS.

RESULTS

Results of the analysis of variance showed a highly significant difference between the stations in terms of the uptake of lead by different organs (Table-1). There is a significant difference between all the stations in terms of the uptake of lead in soil and plant organs. Lead concentration in soil was much higher than in plants as for all the stations. This shows that the most contaminated part of any station is the soil. A comparison between plant organs in terms of lead absorption showed that shoots were more highly affected by pollution and contained a higher lead level than roots.

Table-1. Analysis of variance related to the absorption of lead in soil and plant tissues of long oak apple trees in different stations.

Mean squares (MS)				
Sources of change	**Degrees of freedom**	**Root**	**Leaf**	**Soil**
Replication	4	23217.956	921470.519	90.143
Treatment	3	1830881.2 **	100792538.2 **	12154.9 **
Standard error (E)	12	16546.573	32053.719	66.60
Coefficient of variation (% CV)	-	14.34	11.42	12.42
**. Significant at the 1% level				

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Table-2. Average comparison of data related to the absorption of lead in soil and plant tissues of long oak apple trees in different stations using the Duncan test.

Treatments	**Soil** (mg/kg)	**Root** (µg/kg)	**Leaf** (µg/kg)
Station 1	43.08 c	575.2 b	2623 c
Station 2	77.82 b	1445 a	6936 b
Station 3	128.4 a	1362 a	10640 a
Station 4	13.66 d	205.2 c	587.2 d

- Letters 'a' and 'd', respectively, show the average maximum and minimum
- Comparisons with common letters are not significantly different at 5% level Dunnett test
- The unit for the amount of lead in soil is milligrams per kilogram and the unit for the amount of lead in plant tissues is micrograms per kilogram

Results of the comparison of data show that the highest amount of lead concentration in leaves belonged to station three (= 10, 640 micrograms of dry matter). This is almost twenty times the amount of lead accumulated in oak leaves in stations four (= 587.2 µg). After station three, station one and two ranked lower in terms of lead levels in the leaves (See Figure-1). The highest proportion of leaf-to-root lead absorption belonged to station three (= 7.8), which indicates a high air pollution and thus leading to a greater uptake by oak leaves in this station compared to the other stations. The lowest proportion of leaf-to-root lead absorption belonged to the control station, that is station four (= 2.9) (See Figure-2).

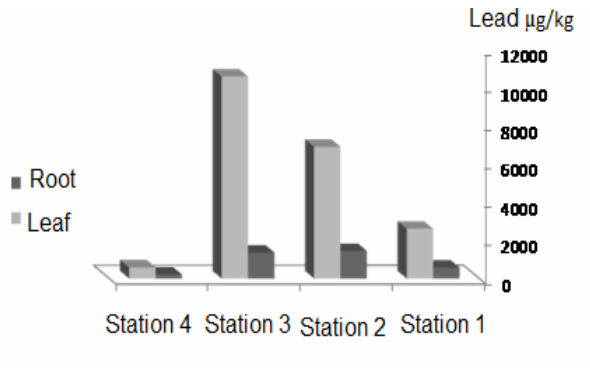

Figure-1. Comparison between lead absorption by leaves and by roots of oak trees in different stations of the study.

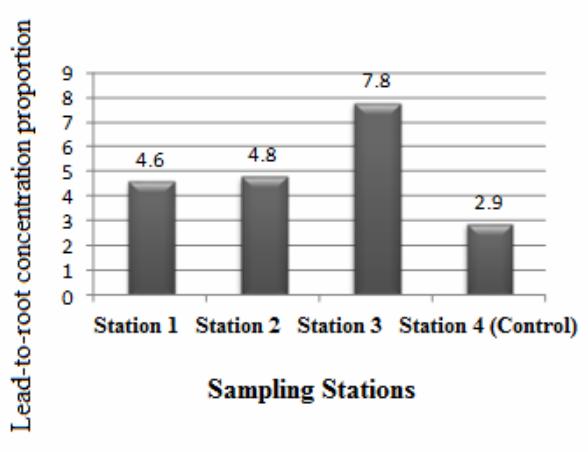

Figure-2. Comparison of the amount of lead absorbed by the leaves to the amount of lead absorbed by the root in different stations of the study.

DISCUSSIONS

Generally, the amount of lead absorbed by leaves was much higher than by roots in all stations. One of the major reasons for this is that leaves are exposed to polluted air. Thus, as we go away from high-traffic stations, a decline of lead concentration can be seen in soil and roots and leaves. Lead uptake by plants depends more on soluble compounds of the plant than on the total amount of lead in soil. Studies in this field showed that insoluble salts of lead are readily absorbed by surface roots of plants. Overall, the amount of lead concentration differs in different plants, but its normal level in plants is less than 5 ppm (Abbaspoor *et al*., 2004).

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