PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 24 (9) 1617-1623 September 2020

Assessment of Heavy Metals Concentrations in Roadside Canola Fields in Mazandaran Province, Iran

[1]BABAEI, S; *[2]KHAKIPOUR, N

[1] *Department of Food Science and Technology*, *[2]*Department of Soil Science, Savadkooh Branch, Islamic Azad University, Savadkooh, Iran*

**Corresponding Author Email: nazanin_kh_43713@yahoo.com; Other Author Email: sarababaee67@gmail.com*

ABSTRACT: Contamination of agricultural products with heavy metals in soil and air is considered as serious threat to the quality and safety of these products. Cars and vehicles are among the major sources of heavy metals such as lead, iron and copper in the environment surrounding roads and highways. According to carcinogenic and destructive effects of these elements on human health, the aim of this study is to measure the concentrations of lead, iron and copper resulting from the traffic of vehicles available in the soil and canola plants growing in the central regions of MAZANDARAN province in Iran. In this research, sampling was conducted randomly and the values of mentioned elements were measured using flame atomic absorption device according to standard methods. The results showed that the levels of lead, iron and copper elements were higher in canola plant samples, including root, aerial parts and seeds, compared with the respective cultivated soils. The results indicated that the contamination of canola plant with mentioned pollutants has been mostly through aerial parts compared to the soil.

DOI: https://dx.doi.org/10.4314/jasem.v24i9.20

Dates: Received: 10 August 2020; Revised: 16 September 2020; Accepted: 22 September 2020

Keywords: Lead, Iron, Copper, Canola, Roadside Fields

Canola plant, *Brassica Napus* L., is a member of family Brassicaceae, known as the third largest source of vegetable oil in the world. Oilseeds including canola are the second largest source of energy production in human nutrition after crops. On the other hand, press cake obtained from respective industrial processes due to being rich in protein is a key composition in livestock, poultry and fish foods. In addition, oil is one of the significant qualitative features of canola (AHMADI, 2010). Currently, gradually raising concentrations of heavy metals in soil are of the major environment challenges because microorganisms could not decompose them. Soil contamination by heavy metals is one of the most important environmental problems around the world. Heavy metals could enter into the environment through the use of urban sewage, pesticides, fertilizers, irrigation with wastewaters, paint industry, cement factories, rubber manufacturing, fuel and metal smelting industries (DINAKAR *et al*., 2008). Contamination of agricultural products such as canola is one of the possible environmental pollution, leading to transfer and accumulation of the heavy metals into such products under certain conditions like soil and water contamination and proximity of farms to industrial centers, sewages and roads. In this regard, the most common soil-contaminant heavy metals are cadmium, chromium, copper, mercury, lead, and zinc (ABEDI KOUPAI *et al*., 2007). Fossil fuels, wearing down of tires and other components, spilling substance from vehicles and trucks and other machine activities could find their way into the roadside environment (Sharma and Prasad, 2010, Wei Wu Yang, 2010). Although heavy metals accounted for small part of pollution caused by transportation, but given that they remain longer in the environment could play a potential role in the quality of roadside environment in long term (GREIGA LAVISENY *et al*., 2005). Based on researches, roadside soils of highways have been severely contaminated by the heavy metals (Muller *et al*. 2005; RAHMANI *et al*. 2000; KIALASHAKI *et al*., 2010). The most common toxic metals, which could find their way to the environment through the traffic of vehicles, include lead, cadmium, chromium, nickel and zinc (Grace et al., 2009; Zhao et al., 2010). Lead and cadmium do not play a known role in living organisms and if their concentrations reach more than certain levels, they could cause toxicity in plants and humans; but zinc and nickel are two of the essential nutritional element for plants and animals. However, high levels of these elements could be toxic (Ahmed et al., 2007). The lead added to fuel and automotive batteries (ADI and OSIBANJO, 2009) could be the source of roadside lead. In addition, concentration of lead in soil is significantly associated with traffic volume (RAHMANI *et al*., 2000; ONDER *et al*.,

**Corresponding Author Email: nazanin_kh_43713@yahoo.com*

2007). Although the maximum allowable lead in gasoline (as tetraethyl lead) has been determined 0.15 grams per liter by European Commission (EU) and the United States Environmental Protection Agency (EPA) (Sharma and Prasad, 2010) and amount of lead in petrol has been remarkably reduced based on regional and international standards, but the increasing number of cars and other vehicles could affect the lead release. On the other hand, the tires of vehicles could present lead to the roadside soils (Sharma and Prasad, 2010). In addition, non-compliance with international standards in Iran has also led to the contamination of roadside environment. Consumption of plants grown in these environments by humans or animals could help to penetrate of these contaminants into the food chain and cause secondary effects of these compounds. Limited studies (RAHMANI, 1995; RAHMANI *et al*., 2000; KIALASHAKI *et al*., 2011) have been conducted so far on contamination of soil and plants of roadsides in Iran, indicating increased contamination levels in these environments by heavy metals especially lead, cadmium, arsenic, copper and other heavy metals. JAVAN SIAMARDI *et al*. (2014) assessed the concentrations of heavy metals (iron, nickel, copper, zinc and lead) in agricultural soil of the central part of SISTAN, Iran. The results demonstrated that the levels of iron, lead, nickel, zinc and copper in agricultural soils of respective areas were below the standard allowable level determined by World Health Organization (WHO), and there was no problem in soil health in this regard. BEHRAVESH *et al*. (2013) investigated and determined the sources of heavy metal contaminations in traffic dust of Mashhad city, Iran, by using sequential extraction method. For this purpose, 23 surface soil samples from the main three routes including the whole city were collected to measure total concentrations of Ni, Zn, PB, Cr and Cu. The results of analyses demonstrated the higher concentrations of lead, copper, zinc and nickel than the average concentrations of these metals in the upper part of the Earth's crust. RASHID SHOMALI and KHODAVERDILOO (2012) in Iran investigated soils and plants around the URMIA-SALMAS highway in terms of contamination by some of the heavy metals. The results showed that the concentration of these metals in soils and plants in roadside are significantly higher than the reference samples. In addition, surface soil and plants in studied regions with background surfaces were contaminated relatively. The soils and plants of this roadside were contaminated especially by lead. Based on this research, it is necessary to manage soil and grazing of roadside plants. MASOUDI *et al*. (2012) investigated the concentration of lead, cadmium, copper and zinc in roadside soils of the GHAEMSHAHR-SARI road. Their results demonstrated that concentrations of all these three metals, except for cadmium, are significantly different in nearest distance to the roads. Due to the difference in wind direction and strength, some differences were observed in concentrations of heavy metal between the two sides of the road. Study of NAZEMI *et al*. (2010) conducted on the levels of arsenic, chromium, cadmium, lead and zinc elements in vegetables grown in the outskirts of the SHAHROOD city in SEMNAN province, Iran indicated that the mean concentrations of chromium, lead and cadmium in these vegetation were over the standard level for plants presented by the World Health organization (WHO) and Food and Agriculture Organization (FAO). Municipal and industrial wastewaters are the main reasons of heavy metals contamination in farmed vegetation in outskirts of the SHAHROOD city.

This study aimed to investigate the absorption levels of heavy metals in canola grown in roadside fields and respective cultivated soils comparing with the national standards.

MATERIALS AND METHODS

The study area is a part of the central lands of MAZANDARAN Province located in longitude of E 52°47.798', E 52°54.005', E 52°54. 483' and latitudes of N 36°29. 227', N 36°32.657', N 36°35. 916', where is considered to be one of the most important areas of the country in terms of agricultural, industrial and municipal practices as well as population density. The sampled area consists of roughly five hectares. Sampling of products was carried out from agricultural lands related to roads of BABOL to GHAEMSHAHR, GHAEMSHAHR to JUYBAR and JUYBAR to BAHNEMIR. In the present study, canola samples and leaves of the same plant and soil (0-30 cm depth) at the foot of the plant were collected by random sampling method with equal chance of selection of each item. Fifteen repeated samples from canola plant and respective cultivated soil were gathered and totally 30 samples were delivered into the laboratory. All tests were repeated three times. In order to the preparation of samples, 20 grams of canola samples inside a crucible were weighed using a digital scale with accuracy of 0.001 gram. To perform incineration, the crucibles containing sample were placed inside a furnace with a maximum temperature of 500± 50°C for at least 8 hours. After full conversion of the samples to ash, 50 ml of 6M hydrochloric acid was added to the crucible to soak all the contents. Then the added acid was evaporated by placing the crucible on a water-bath or heater. To dissolve the remaining contents inside the crucible, 30 ml of 0.1M nitric acid was added to the crucible so that all the contents were soaked in acid. Flame atomic absorption spectroscopy (GE 712295) was used to measure the lead, iron and copper. The device was calibrated for the measurement of elements including wavelength, gas flow rate, temperature and other systemic factors settings according to manufacturer's instructions (National Standard No. 4089). The soil samples were dried in air, crushed by a plastic hammer, and then passed through a 2-mm sieve for doing chemical analyses. DTPA extractor, calcium chloride and Tri ethanolamine were used to measure the absorbable concentration of heavy metals in soil and the pH of the solution in the extractor was adjusted about 7.3. Then concentrations of heavy metals were measured by AAS.

RESULTS AND DISCUSSION

The results of investigating the mean concentrations of some heavy metals including iron, copper and lead in the agriculture soil of canola farms and the mean of these elements in plants grown in the soil of different parts of the farm are given in following Figures. All the investigations are aimed to determine the amounts of heavy metals in soil and plants in comparison with the existing standards and reports on safety of products.

Iron (Fe): As can be seen in figure 1, there are some fluctuations in iron levels of different parts of soil, while the iron content was 10.70 mg/kg in the soil sample 1 and 2.70 mg/kg in soil sample 3 (approximately 75% variation). The mean iron content in canola had no uniform and identical change trend and its variation range was about 73% (261 vs. 72.23 mg/kg respectively in samples 11 and 6). According to existing WHO standards, 2000 mg/kg of iron in the soil is considered as a low contamination. It is clear that mean level of iron in the soil of canola farms and the iron level in canola plant are in the standard range and there is no problem for its consumption.

Copper (Cu): The mean levels of copper in the canola farm soil and canola plant are given in Figures 2. The results demonstrated that the mean level of copper content in the soil was significantly higher in first 10 samples compared to the other samples and there was a relative uniformity among these mean values. The mean change of copper level in first 10 soil samples is about 30% (the highest and lowest mean levels of copper are respectively observed in the soils No. 5 and 8). Meanwhile, the respective mean change in the last five soil samples is reached to 20%. Overall, maximum level of copper with a mean of 4.70 mg/kg was found in the soil No. 5 and the lowest level in the soil No. 11 (2.13 mg/kg). Comparison of the standard mean level (according to WHO, 35 mg/kg of copper in the soil is considered as a low contamination) and the studied soil (3.51 mg/kg) indicated the range of studied soil. The results were almost the same for the studied plants, so that the standard level was 15-60 mg/kg of copper in plants; its comparison with the mean level of copper in studied canola (5.65 mg/kg) demonstrated the product safety in terms of contamination and toxicity with this element.

*Lead (*PB*):* The mean lead levels in studied soil and plant are given in Figures 3. The results demonstrated that the changes in studied soil samples was quantitatively decreasing so that the mean PB level in more far farms (No. 15) was much less than nearest farms. The number of respective changes reached to about 90% (6.70 and 0.71 mg/kg respectively in soils No. 3 and 16). The mean level of PB in the soil was reported 4.10 mg/kg. The range of this element in soil was reported from 83 (low contamination) to 130 (severe contamination) and the allowable level of PB is considered 10 mg/kg of PB allowed in soil. Therefore, it seems that studied soils were in the normal range and were not contaminated by PB. The changing trend was also observed in mean PB level in studied canola plants. The highest and lowest PB levels were respectively found in canola No. 11 (6.00 mg/kg) and canola No. 12 (2.04 mg/kg). The mean change of PB level in plant was 66%. In the conducted investigations, it was reported that the allowable PB level for human consumption is 2 mg/kg, and the usual range of this metal in the plant has been reported 0.1-10 mg/kg and the range of 30-300 mg/kg of this element has been considered as critical level. Therefore, given the mean PB level of 4.36 mg/kg in the studied plants, it can be clearly seen that the level of respective metal is in the normal range and it is less than critical range. Assessments of the levels of Fe, Cu and PB in soils and plants, shown in Figures 1 to 4, demonstrated that the mean levels of iron in the soil and the plants have significant differences ($P < 0.05$) among all farms, but these values were not observed in mean levels of Cu and PB among the all farms and plants, while the mean levels of these elements in most cases were higher in the canola plants compared to the farm soils. However, this trend was not homogeneous and was reverse in some cases and the levels of Cu and PB in soils were more than the studied plants. Overall, comparison of the mean levels of these elements in soil and plant in the studied farms (Figure 10) indicates that the mean level of Fe and Cu in soil and plant are statistically different ($P < 0.05$) and these levels in the plant were more than the farm soil. Therefore, it seems that aerial parts of plant have the ability to absorb these elements through the roots. The mean level of PB in farm soil and the studied canola plants has no statistically significant difference. Therefore, although the levels of heavy metals in studied soil and plants was numerically less than the critical and the allowable ranges, but contamination or presence of these elements was proved in all studied farms and plants. In addition, according to performed comparisons of the mean levels of these elements in soils and plants, it was observed that the Cu and PB in some cases have the ability to be absorbed by the aerial parts of the plants, because the levels of these elements in plant were more than studied soils. Water, soil and plants contamination by heavy metals is caused by industrial, agricultural and urban activities (SOLHI *et al*., 2005).

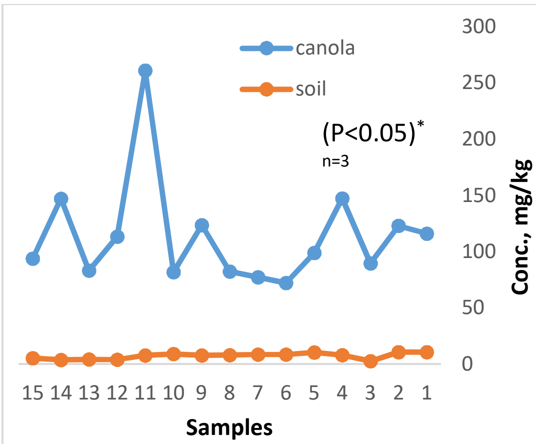

Fig 1- Average concentration of iron element in studied soil and canola samples (mg/kg)

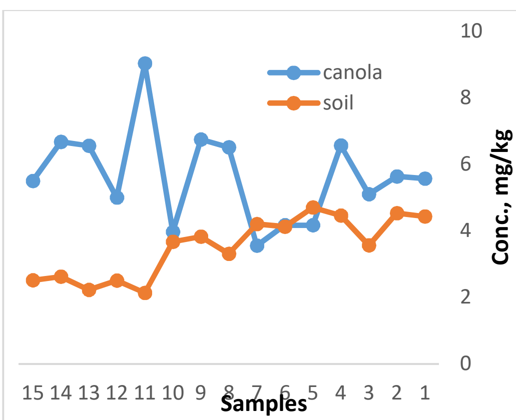

Fig 2- Average concentration of copper element in studied soil and canola samples (mg/kg)

The heavy metals are stable pollutants and tend to bioaccumulation or bio concentration in living organisms (US EPA, 2000 and WHO, 2004). The contamination of oil seeds and other nuts with heavy metals is important for several reasons including the possibility of direct feed applications, used in food formulations and the possibility of transmission to edible oils.

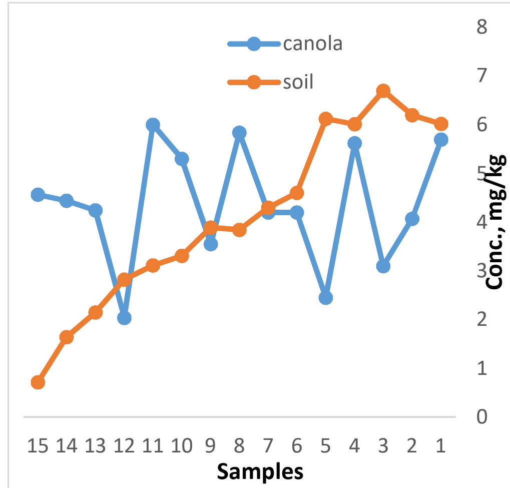

Fig 3- Average concentration of lead element in studied soil and canola samples (mg/kg)

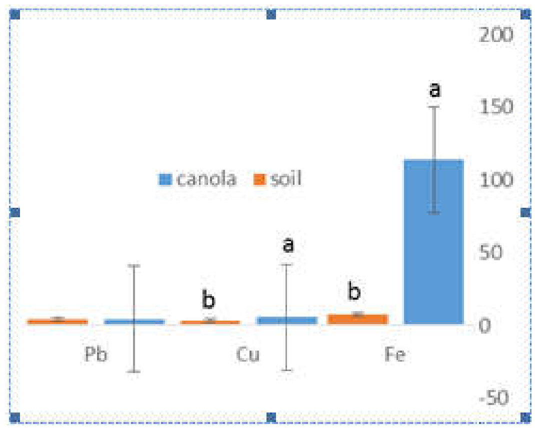

Fig 4- Average concentration of elements of iron, copper and lead in studied soil and canola samples (mg/kg)
[a-b] Columns with dissimilar letters have statistically significant difference (n=45, P<0.05)

Therefore, appropriate methods of analysis should be employed to determine the extent of possible contamination. This study evaluated 15 samples of canola along with their respective cultivated soils as an indicator of contamination with heavy metals in roadside fields in the central regions of MAZANDARAN province.

In this study, the concentrations of lead, iron and copper were measured in 15 samples of canola planted in the central regions of MAZANDARAN province in 2015 (respectively, 47.114±29.022, 1.5±42.64 and 4.1±35.21), which are much less compared to the permitted standard limits of Iran and World Health Organization (WHO). Ansari *et al*. in a study on 16 varieties of oil sunflower seed in Pakistan showed that all varieties contained considerable quantities of zinc and some varieties had high levels of cadmium and lead, which can affect the quality of the obtained oil and consumer health. It was observed little difference between the amounts of heavy metals in canola samples in this study with previous findings about other oilseeds including sunflower in other countries (Ansari *et al*., 2009). The heavy metal emissions from vehicles is one of the main sources of metal pollution in urban environments due to the high volume of traffic (SHOKOUHIAN and GHAZINEJAD, 2010; CHRISTOFORIDIS & STAMATIS, 2009). The heavy metals produced by vehicle exhaust and tire abrasion and the use of brake can be deposited in dust and urban soils (THORPE & HARRISON, 2008). Furthermore, the heavy metals released from road traffic cause pollution of urban runoff because rainfall washes the particles from the atmosphere and surface the streets and enters them into surface water and runoff as well as leads to the transfer of heavy elements by this way (WEI *et al*., 2008). Net heavy metals in the soil may not have any direct impact on the growth and development of plants, but the forms of these elements, which are available to plants and absorbed into the plant through the soil solution, affect the growth and development of plants (KADKHODAEI, 2006). Therefore, absorption of chemical species from the soil solution by plants depends on many other plant factors. These features and behaviors in unique or different plant species are important in determining the uptake of heavy metals from the soil. On the other hand, different reactions of plants and a variety of environmental changes also lead to differences in the uptake of heavy metals from the soil (MONDOL *et al*., 2011). The present study examined the contamination levels of soil and plant of roadside farms, which also noted. The results also showed that the mean concentration of heavy metals was higher in BABOL road to GHAEMSHAHR than GHAEMSHAHR road to JUYBAR and JUYBAR road to BAHNEMIR, but this increase had no regular trend. For example, the level of plant contamination with lead was higher in BABOL road to GHAEMSHAHR than JUYBAR road to BAHNEMIR, and less than GHAEMSHAHR road to JUYBAR. This is probably due to the relative size of the particles or wind speed and direction. Thus, traffic can be a source of contamination of soil and roadside plants.

According to the results of this study, it can be noted that comparison of contamination levels of the canola samples and respective cultivated soil with heavy metals will determine that the contamination level of canola samples was higher compared to respective cultivated soil. It could be due to the higher absorption of pollutants through the aerial parts compared to the roots and soil. The lead is not very soluble in the soil, however, is mostly absorbed by root hairs and is stored in the cell walls. In many studies, the lead absorption is very impressive through aerial parts and has been further reported by the roots (KADEM HAGHIGHAT and GHODDUSI, 1985). These results correspond to the findings of the present study.

The acceptable limit of lead has been declared to 3 mg/kg in plants by Allen (1989), 2.5 mg/kg in vegetables by PFA and 0.3mg/kg in vegetables by CODEX (SHARMA and PRASAD, 2010). RADWAN *et al*. in 2006 analyzed some samples of crops including strawberries, cucumbers, dates and vegetables to inform public opinion in Egypt concerning evaluation of agricultural production in terms of heavy elements. They measured the four elements in listed products according to the carcinogenic effects of cadmium and lead as well as the usefulness of zinc and copper adequately in the diet. Their results showed that leaf vegetables such as lettuce and spinach have the highest levels of lead and cadmium among other products, estimated the daily intake of these nutrients in agricultural products and found that these amounts were lower than reports of FAO and WHO.

Conclusion: Numerous studies have been done on the accumulation of heavy metals in soils (SEMHI and Al-KHIRABASH, 2010). Although it is difficult to control heavy metal pollution but it seems that continuous analyses of canola seeds for preventing metal contamination are effective measures to control these dangerous toxins. As a result, the plants grown in polluted places are the sources of pollution dangerous to consumers. Therefore, further studies are required in relation to measure the concentration of heavy metals in soils and plants grown in environments surrounding roads.

REFERENCES

Abedi Koupaei, J; Daadmehr R; Julazadeh F (2007). Phytoremediation Way to Reduce the Emission of Industrial Waste. 11th Congress of Metallurgical Engineers Society of Iran, Isfahan.

Adie G U; Osibanjo O (2009). Assessment of Soil Pollution by Slag from an Automobile Battery Manufacturing Plant in Nigeria. *Afr. J. Environ. Sci. Technol*. 3(9): 239-250.

Ahmad M S A; Hussain M; Saddig R; Alvi A K (2007). Mungbean: A nickel indicator, accumulator or excluder? *Bul. Environ. Contam. Toxicol*. 78: 319-324.

Ahmadi, M (2010). Effect of Zinc and Nitrogen Fertilizer Rate on Yield and Yield Components of Oilseed Rape (*Brassica Napus* L.). *Am-Euras. J. Agric. Environ. Sci*. 7(3): 259-264.

Ansari, R; Gul Kazi, T; Jamali, M K; Arain, M B; Wagan, M D; Jalbani, N (2009). Variation in Accumulation of Heavy Metals in Different Verities of Sunflower Seed Oil with the Aid of Multivariate Technique. *Food Chemistry*. 115: 318–323.

Behravesh, F; Mahmudy Gharaei, M H; Ghassemzadeh, F; Avaz Moghaddam, S (2013). Determination of Heavy Metals Pollution in Traffic Dust of Mashhad City, and Its Origin By Using "Selective Sequential Extraction" (Sse) Procedure. *Engineering Geology and Environment* 24: 141-150.

Christoforidis, A; Stamatis, N (2009). Heavy Metal Contamination In Street Dust And Roadside Soil Along The Major National Road In Kavala'sregion. *Greece Geoderma*, 151: 257–263.

Dinakar, N; Nagajyothi, P C; Suresh, S; Udaykiran, Y; Damodharam, T (2008). Phyto Toxicity of Cadmium on Protein, Praline and Antioxidant Enzyme Activities in Growing *Arachis Hypogaea* L. Seedling. *J Environ Sci*. 20: 199-206.

Faiz, Y; Tufail, M; Javed, M T; Chaudhry, M M; Siddique N (2009). Road Dust Pollution of Cd, Cu, Ni, Pb and Zn along Islamabad Express Way. *Pakistan Microchem J*. 92: 186-192.

Grigalaviciene, I; Rutkoviene, V; Marozas V (2005). The Accumulation of Heavy Metals Pb, Cu and Cd At Roadside Forest Soil. *Pol J Environ Stud* 14(1): 109-115.

Iranian National Standard (2011). Measurement Of Lead By Atomic Absorption Spectroscopy, Institute Of Standard And Industrial Research Of Iran, Standard Number Of 4089.

Javan Siamardi, S; Rezaei Kahkha, M R; Safaei Moghaddam A; Noori. R (2014). Survey Of Heavy Metals Concentration (Fe, Ni, Cu, Zn, Pb) In Farmland Soils Of Sistan Central Part. *Journal Of Environmental Health Engineering*. 2 (1): 46-53.

Kadem Haghighat, M; Ghoddusi, J (1985). Distribution of Lead in Plantain Leaves Relative To Traffic Centers In Various Regions Of Tehran. Jihad University. Tehran.

Kadkhodaei, M (2006). Effect Of Wastewater Of Esfahan Steel Company On Some Soil Properties In Several Tree Species. Master's Thesis In Range Management, Department Of Natural Resources, Isfahan University Of Technology.

Kaysi, I; Mamassani, H S; Arnount, S; Kattan, L (2000). Phasing Out Lead In Automotive Fuels: Conservation Considerations, Policy Formulation And Application To Lebanon. *Transportation Research Part D*. 5: 403-418.

Kialashaki, A; Ahmadi, T; Habibi, G (2011). The Determination Of The Amount Of Lead Existing In The Soil And Plant Along The Roads With The Heavy Traffic In Nowshahr And Chalous Cities (North Of Iran). *Ann Bioll Res*. 2(3): 412-418.

Masoudi, S N; Ghajar Sepanlo, M; Bahmanyar, M A (2012). Distribution Of Lead, Cadmium, Copper And Zinc In Roadside Soil Of Sari-Ghaemshahr, Rood, Iran. *Agricultural Research*. 7: 198-204.

Moller, A; Muller, H W; Abdullah, A; Abdelgawad, G; Utermann, J (2005). Urban Soil Pollution In Damascus, Syria: Concentrations And Patterns Of Heavy Metals In The Soils Of The Damascus Ghouta. *Geoderma*. 124: 63-71.

Mondol, M N; Chamon, As; Faiz, B; Elahi, S F (2011). Seasonal Variation Of Heavy Metal Concentration In Water And Plant Samples Around Tejgon Industrial Area Of Bangladesh. *J Bang Acad Sci* .35(1): 19-41.

Nazemi, S; Asgari, A; Raei, M (2010). Survey The Amount Of Heavy Metals In Cultural Vegetables In Suburbs Of Shahroud. *Iranian Journal Of Health And Environment* .3 (2):195-202.

Onder, S; Dursun, S; Gezgin, S; Demibas, A (2007). Determination Of Heavy Metal Pollution In Grass And Soil Of City Center Green Areas (Konya, Turkey). *Pol J Environ Stud*. 16(1): 145-154.

Radwan, M A; Salama, A K (2006). Market Basket Survey For Some Heavy Metals In Egyptian Fruits And Vegetables. *Food and Chemical Toxicology*. 44(8):1273-78.

Rahmani H (1995). Soil Contamination by Elements Resulting From Vehicles Within Some Highways

Of Iran. Master's Thesis In Soil Science. Isfahan University Of Technology.

Rahmani H; Kalbasi M; Haj Rasouli H (2000). Soil Contamination By Elements Resulting From Vehicles Within Some Highways Of Iran. *Science And Technology Of Agriculture And Natural Resources*. 4:31-42.

Rashid Shomali A; Khodaverdiloo H (2012). Contamination Of Soils And Plants Along Urmia-Salmas Highway (Iran) To Some Heavy Metals. *Journal Of Soil And Water Science*. 22: 172-157.

Semhi, K H; Al-Khirabash, S (2010). Dry Atmospheric Contribution To The Plant-Soil System Around A Cement Factory: Spatial Variation And Sources, A Case Study From Oman. *Water, Air And Soil Pollution* 205: 343-357.

Sharma, S; Prasad, F M (2010). Accumulation Of Lead And Cadmium In Soil And Vegetable Crops Along Major Highways In Agra (India). *Electronic J Chem*. 7(4): 1174-1183.

Shkouhian, M; Ghazinejad, M (2010). Traffic And Its Role In Environmental Pollution.5th National Congress On Civil Engineering, May 4-6, 2010, Ferdowsi University Of Mashhad, Mashhad, Iran.

Solhi, M; Hajabbasi, M A; Shareatmadari, H (2005). Heavy Metals Extraction Potential Of Sunflower (*Helianthus Annus*) And Canola (*Brassica Napus*). *Caspian J. Environ. Sci*. 3: 1. 35-42.

Thorpe, A; Harrison, R M (2008). Sources and Properties of Non-Exhaust Particulate Matter from Road Traffic: *A Review Science Total Environmental*. 400 (1–3): 270–282.

Us Epa (2000). Arsenic Occurrence In Public Drinking Water Supplies. Epa 815-R-00-023, Washington D.C.

We, B; Yang, L (2010). A Review of Heavy Metal Contaminations in Urban Soils, Urban Road Dusts and Agricultural Soils from China. *Microchem. J*. 94: 99–107.

Wei, Z H; Bo, B; Lei, L (2008). Heavy Metal Contamination of Road-Deposited Sediments in a Medium Size City of China. *Environ. Monit. Ass*. 147: 171–18.

Who (2004). Guidelines for Drinking–Water Quality. Vol. 1, 3rd Ed., World Health Organization, Geneva.

Zhao, H; Cui, B; Zhang, K (2010). The distribution of heavy metal in surface soils and their uptake by plant along road side slop in longitudinal range Gorge region, China. *ENVIRON EARTH SCI.* 61: 1013-1023.