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Full Length Article

Effect of Heavy Metals Pollution on Pistachio Trees

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ABSTRACT

The paper presents a recent evaluation of lead (Pb) and cadmium (Cd) in soil (0-10 cm) and pistachio tree (leaf & nut) collected from pistachio orchards around Kerman–Rafsanjan road in Iran. The Pb and Cd content of the pistachio. A comparison of the pollution level of the samples showed significant effect of the pollution of the soil on the Pb and Cd content of pistachio orchards samples. The Pb and Cd content of the pistachio orchards near the main road were greater than far away orchards.

Key Words: Pollutants; Pistachio orchards; Contamination; Heavy metals

INTRODUCTION

In modern economics, various types of activities, including agriculture, industry and transportation, produce a large amount of wastes and new types of pollutants. Soil, air and water have traditionally been used for the disposal of all these wastes. The most common kinds of waste can be classified into four types: agricultural, industrial, municipal and nuclear (Alloway, 1990). Agricultural wastes include a wide range of organic materials (often containing pesticides), animal wastes and timber by-products. Many of these, such as plant residues and livestock manure, are very beneficial if they are returned to the soil. However, improper handling and disposal may causes pollution. Industrial waste products may be in gas, liquid or solid form. The most important gases are carbon dioxide (CO_2), carbon monoxide (CO), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2). They are produced by combustion in industry and by automobiles and they pose a hazard to the environment (Panaiotu *et al.,* 2005).

Some factors of the ecological nature can cause a great risk, especially for public health. It has been shown that heavy metal pollution is more damaging to health than the other types (Chalbi & Hawker, 2000). Heavy metals from soil with water (also in vegetables) get into human organisms, poisoning and destroying them. The most dangerous and synergetic are the effects when the damage is realized by separate concentrations not exceeding the standard level (Gavi *et al.,* 1997). It is rather difficult to evaluate the synergistic effect of heavy metals because they can accumulate and their effect may be latent. Of those, lead (Pb) and cadmium (Cd) causes accumulation and in long term cause an insufficiency in different tissue and organs. Both Cd and Pb not essential for plants or animals and although they are phytotoxic their uptake differs among plant species and are accumulated in different plant organs as follow: leaves > storage roots > fruits and grain (Chaney & Ryan, 1993; Epstein, 1997).

The objective of this study was evaluation the rate of Pb and Cd in soil and finds the relationship between soil concentration and pistachio pollution in this area.

MATERIALS AND METHODS

Study area: Rafsanjan is a city of Kerman province. Distance between Kerman and Rafsanjan is 100 km. Kerman-Rafsanjan road is very busy, an average of 3680 vehicles per day passes through this road. There are some pistachio orchards near the Kerman-Rafsanjan road. Selection of these sites was based on several criteria such as pistachio orchards, total number of vehicles passing through the two urban areas (Kerman & Rafsanjan) and position of the field and distance from the main road (Fig. 1).

Sample collection and preparation: Samples of pistachio (leaf & nut) and soil were taken from the six pistachio orchards form the corners of the road between Kerman and Rafsanjan. The pistachio orchards were divided into three sections based on the distance (5, 50 & 100 m) from the main road. For each site, three samples each of pistachio (leaf & nut) and soil (0.5 & 1.5 kg per samples), respectively, were taken from each location, samples were drawn at a depth of 0-10 cm from the surface.

Nut and leaf samples were rinsed with tap water to remove the soil and other visible residues present. The

samples (leaf & nut) were then cut into small pieces and oven dried at 70^0C. After 2-3 days, dried samples were grounded to pass through a 2 mm sieve. One gram of samples was placed in a digestion test tube with 5 mL HNO_3 and 0.5 mL $HClO_4$. The mixture was kept for 24 h at room temperature and then heated on a digestion block at 100^0C for 1 h. The temperature was increased gradually to 200^oC. About 1.5 mL of the extract was diluted with deionized distilled water to 25 mL (Kelepertsis *et al.,* 2001; Panaiotu *et al*., 2005).

Soil samples weighing (1.5 kg each) were air dried, ground using pestle and mortar and passed through 2 mm mesh. Well-mixed samples were extracted by DTPA. The Concentration of total and bioavailable metals were measured with a flame Atomic Absorption Spectrometry (Perkin Elmer, AAnalyst 700). In all cases, standards (stock standard solution of 1000 mg/L concentration) and blank were treated in the same way as the real samples of minimize matrix interferences during analysis.

Pb and Cd analyses: Standard solution for lead and cadmium and also a control solution with the same ingredients were prepared. Determination of lead and cadmium was estimated by atomic absorption spectrophotometer (Zeiss Model AAs. 4 Germany) at 283.3 ppm for Pb and 228.8 nm for Cd and expressed as ppm.

Statistical analysis: A randomized block design consisted of three treatment with three replications was used in this research. The distance from the road (5, 50 & 100 m) was served as a treatment. Spatial distribution of the total concentration of Pb and Cd was analysed with SPSS11.

RESULTS

In the present study the Cd content of the roadside soils ranged from 0.61 to 0.19 mg/kg. The average Cd contents in soil, pistachio (nut & leaf) were 0.46, 0.39 and 0.02 μg g^{-1} dry weight, respectively. The evaluated Cd content in pistachio (nut & leaf) grown in this area could be attributed to many factors including particle size and mass, direction of the prevailing winds, moisture level, level of Cd emanating from vehicular emissions that was derived from traffic density and source of phosphate fertilizer. Regardless of the locations, the average Pb content was highest in pistachio grown left beside the main road, because of prevailing winds. The level decreased to about 17% and 66% within a distance of 50 and 100 m from the main road, respectively (Table I).

DISCUSSION

In terms of distance from the main road, there were high correlations between Cd and Pb content and distance, these were r = 0.97 and r = 0.9987 with $p < 0.005$ for Cd content in nut and leaf of pistachio, respectively and r = 0.97, $p < 0.005$ for Cd contents in the soil (Figs. 2, 3 & 4).

Table I: Mean of Cd and Pb concentration (ppm) in soil and pistachio (leaf and nut) with distance from main road (m)

	Mean of Cd (ppm) with distance from the main road		
Part	5	50	100
Soil	0.57	0.49	0.34
Leaf of pistachio	0.46	0.39	0.33
Nut of pistachio	0.028	0.0175	0.015
	Mean of Pb (ppm) with distance from the main road		
Part	5	50	100
Soil	30.62	25.67	10.67
Leaf of pistachio	0.95	0.72	0.27
Nut of pistachio	0.081	0.051	0.018

Fig. 1: Location of the study area

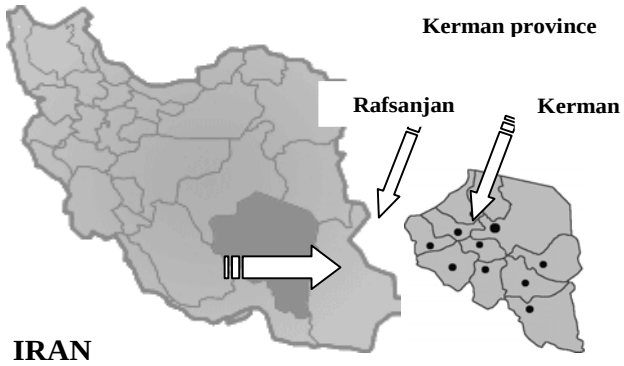
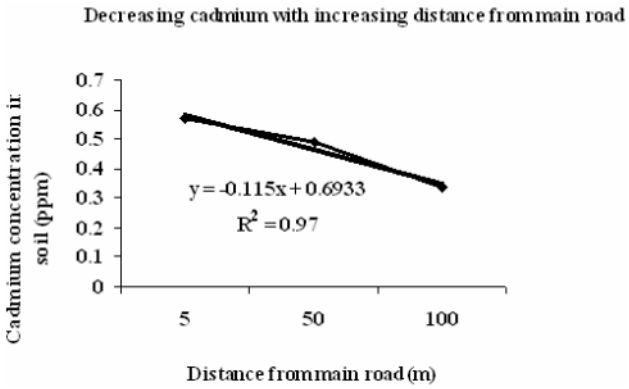


Fig. 2: Decreasing Cd concentration (ppm) with increasing distance from main road (m) in soil



Turer and Moynard (2003) stated that Cd levels in exhaust emissions are related to the composition of gasoline, motor oil, car tires and roadside deposition of the residues of those materials as well as traffic density. Nevertheless, in terms of health hazard due to Cd content, pistachio grown in this area was relatively safe for human consumption. In general, Cd content in many crops including vegetables is categorized as beyond the limits when more than 1.5 μg g^{-1} dry weight (Akbar *et al.,* 2006; Ahmed *et al.,* 2007).

The Cd content in the soil taken at 5 m from the main road was the highest. The value decreased to about 16% and 41% at a distance of 50 and 100 m, respectively from the main road. Based on these result, the average Cd content in the

Fig. 3: Decreasing Pb concentration (ppm) with increasing distance from main road (m) in leaf

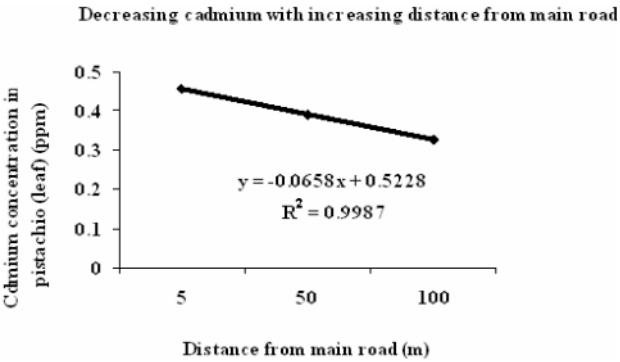


Fig. 4: Decreasing Cd concentration (ppm) with increasing distance from main road (m) in nut

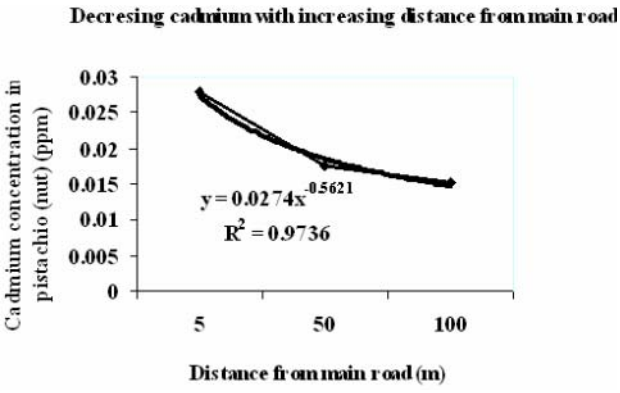
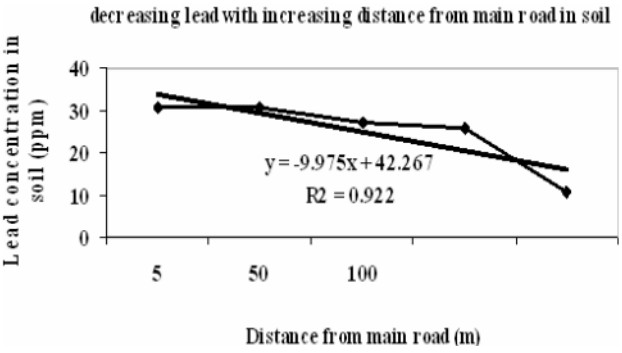


Fig. 5: Decreasing Pb concentration (ppm) with increasing distance from main road (m) in soil



soil still lies within the normal range, because levels of Cd in contaminated soil can reach 3–8 µg g^{-1} dry weight (Cordos *et al.*, 2007).

The level of Pb in pistachio (nut & leaf) was comparable when samples were taken at distances of 50 and 100 m away from the main road. Simple correlation analysis revealed correlations between Pb content and a distance, these were r = 0.9997 and r = 0. 96 with $p < 0.005$ for Pb content in nut and leaf of pistachio, respectively and r=0.92, $p < 0.005$ for Pb content in the soil (Figs. 5, 6 & 7).

Fig. 6: Decreasing Pb concentration (ppm) with increasing distance from main road (m) in leaf

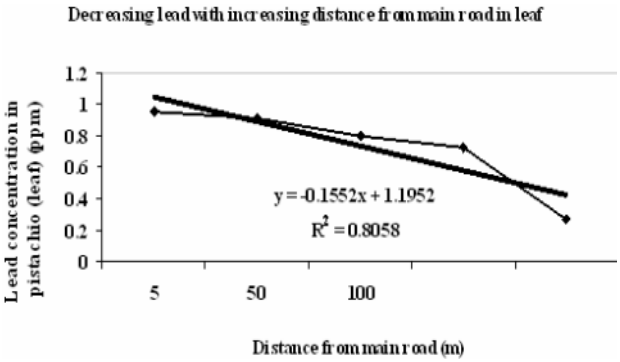
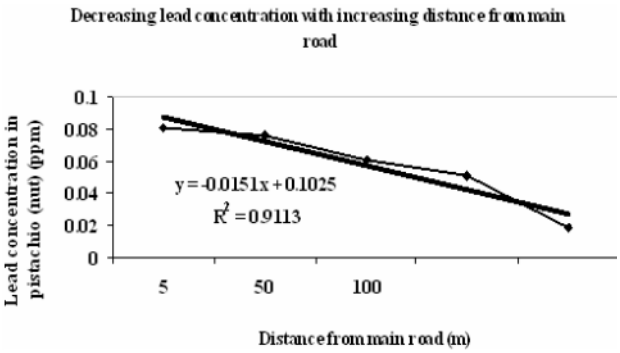


Fig. 7: Decreasing Pb concentration (ppm) with increasing distance from main road (m) in nut



Michalke (2003) and Tribinasu *et al.* (2004) reported that 90-99% of Pb in the leaf material were due to foliar adsorption form vehicular emission. Pb mainly reaches leaves by aerial deposition. Likewise, the aerosol–deposited Pb particles do not penetrate the cuticle of leaves but tend to adhere to leaf surfaces (Dolan *et al.*, 2006). Pb content in crops grown in uncontaminated areas range from 0.1 to 10 ppm on dry weight basis (Flynn, 1999; Umali, 1999). Boon and Soltanpour (1992) reported that Pb contents in leafy vegetable tissue grown in mine dump areas in Aspen Garden soils were between < 5.0 and 45 µg g^{-1}. Referring to daily intake, Zheng *et al.* (2007) reported that daily intakes of Pb for children through the consumption of vegetables around Huludao Zinc plant reached 446.8 µg per day and this would lead to potential health risk. For pistachio (nut & leaf) there is no report on the Pb and Cd pollution. Thus it is difficult to compare the obtained data with the previous reports.

Accumulation of Pb in the soil was also significantly different among distances from the main road. Highest concentration of Pb (30.62 µg g^{-1} dry weight) was noted in the soil left beside the main road (Table I) there were negative correlations between Pb content and distance from road. Pb content in soil was still within the acceptable limits, since in polluted soils, Pb content ranges from 100 to 400 µg g^{-1} dry weight (Cordos *et al.*, 2007).

CONCLUSION

There were high correlations between metal contents (Pb & Cd) and distance from road. In general, the levels of Pb and Cd in pistachio (nut & leaf) were below the standard limit considered safe for human consumption. Further in depth studies are imperative on the hazardous effects of heavy metal on the human healthy.

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