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BIOACCUMULATOR CHARACTERISTICS FOR Pb-Zn OF PRUNUS ARMENIACA L. PLANT (YEŞİLYURT-GÖRGÜ), TURKEY

ABSTRACT

Biogeochemical studies have been carried out on Prunus armeniaca L. plant grown in and around Pb-Zn deposits in Gorgu village and on the soil samples grown on this plant. Chemical analyzes of plant and soil samples taken in the study area were carried out in the ACME analytical laboratory in Canada by ICP-MS method. The average Pb concentration of branch, leaf, fruit and soil of Prunus Armeniaca L. (P. Armeniaca) plant was (mg/kg), respectively; 15.1, 13.7, 3.5 and 1495.5, and Zn concentration, respectively (mg/kg); 29, 44.3, 36.4 and 1831.7. The average BAC (Bioaccumulation Coefficient) values calculated for the Pb element of the P. Armeniaca plant were BAC (branch/soil):0.01, BAC (leaf/soil):0.01 and BAC (fruit/soil):0.004 and the average BAC values calculated for the Zn element, BAC (branch/soil):0.04, BAC (leaf/soil):0.05 and BAC (fruit/soil):0.07. For this reason, this plant is a medium accumulator plant in the locations determined for Cu, Mo and Zn elements.

Keywords: Accumulator Plant, BAC (Bioaccumulation Coefficient) Prunus armeniaca L, Pb-Zn, Yeşilyurt-Görgü

1. INTRODUCTION

The amount and extent of mineral deposits and diversity of by-products is necessary in the world economy. However, metals can cause new and growing problem [1]. The presence of toxic metals in soil can result in serious consequens such as damage of human and animal health, ecosystems, agriculture and food chain [2 and 3]. In plants accumulation of heavy metals is of great importance in food contamination through the soil root interface [4]. Metals such as Co, Cu, Fe, B, Mn, Zn and Ni are necessary for plant growth and development. These metals contribute to the function of many proteins and enzymes for normal plant growth [5 and 6]. Turkey in the Prunus armeniaca L. (P. armeniaca) (Apricot) producer (about 13%) is in first place in the world. Malatya in eastern Turkey, is an important area for the production, cultivation and processing of P. armeniaca plant. The soil of the region, climate and environmental conditions (with a high content of sugar and water) is important in the training of P. armeniaca plant [7]. P. armeniaca plants are a dwarf tree. The leaves are round and pointed. Flowers are pinkish white. Usually, the fruit is a hard core, from yellow to orange or red on the side exposed to the sun [8]. Turkey ranks the first in growing wet P. armeniaca in the world Spain, Italy, United States Community, Iran, France, Greece and USA follow [9]. In the study area P. armeniaca plant is densly produced. Therefore, distribution depending on the distance of the

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elements in the P. armeniaca plants growing in Pb-Zn polluted soils have been examinated. Moreover, it has been determined that P. armeniaca plant can be an accumulator plant and indicator plant in terms of some elements.

2. RESEARCH SIGNIFICANCE

In the study area, P. armenaca plant grows intensively. For this reason, the distribution of the elements in P. armenaca plants grown in soil contaminated with Pb-Zn was investigated because of their importance. In addition, it has been tried to indicate the importance of an accumulator plant and indicator plant in terms of some elements of P. armenia plant.

3. MATERIALS AND METHODS

Site Description: Study area is located 26km Southeast of Malatya city and 12km West of Yeşilyurt province (Figure 1 and Figure 2) and placed in Permo-Carboniferous Malatya Metamorphites. They are composed of carbonate and sulphide ore minerals; zincite, smithsonite, anglesite, sericite, hydrozinkite, galena, pyrite, sphalerite, limonite and marcasite. 15 soils and 15 plants of P. armeniaca plants samples were collected from surroundings of the Pb-Zn deposit. Görgü (former name Cafana) Pb and Zn deposit is located in Eastern Tauride belt. The area is located in Eastern Taurides, in the Alanya Unit of Özgül [10]. The geodynamic evolution of the Eastern Taurides involving an arc-continent collision between the Keban microplate and Arabian plate occurred during late Campania-Early Maastrichtian in the region of Malatya. The Zn-Pb mineralizations in the area occur within the fault zones cutting the Permo-Carboniferous Malatya metamorphic [11]. The metamorphic consist of limestone’s and marbles [12], intercalated with schist’s [11 and 13]. The metamorphic are overlain by volcano-sedimentary units which are cut by andesitic volcanic rocks [11 and 12]. Quaternary alluvium and slope materials comprise the youngest unit in the area [14] (Figure 1). Mineralization: Görgü mineralization is observed in andesitic volcanic and along the contact of these volcanic with Malatya Metamorphic and the volcano sedimentary units (Figure 1). Önal et al. [11] and Cengiz et al. [12] suggested Görgü mineralization is hydrothermal source-related with andesitic (Paleocene in age: [11] volcanic. The major ore minerals are smithsonite, galena and sphalerite. According to Sağıroğlu [13], sphalerite and galena comprise the early minerals of the paragenesis in Görgu mineralization, while smithsonite represents the alteration product of sphalerite [14].

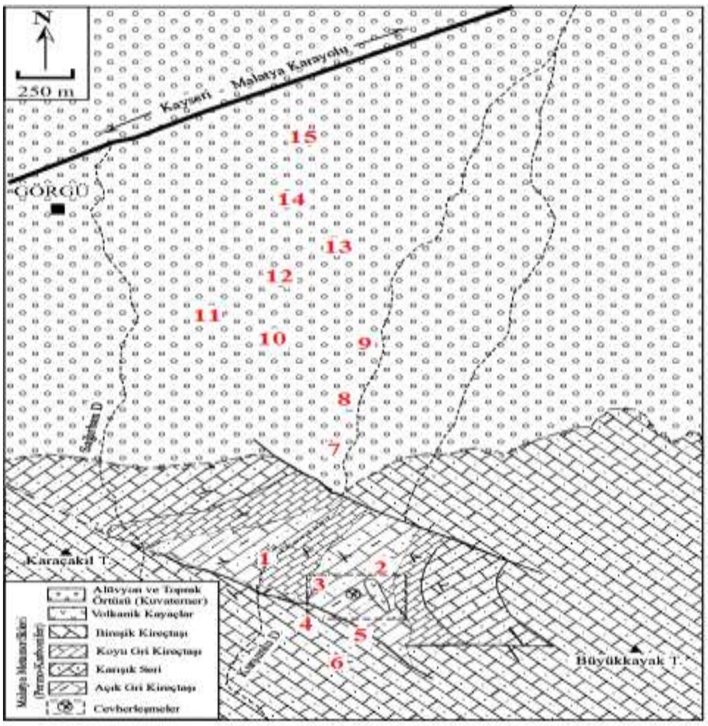

Figure 1. Geological map and plant sample locations of the study area (from modified [13])

Figure 2. Field photograph of around and in the Gorgu Pb-Zn deposits

Plant Samples: Because the soil cover is thicker in this part, more P. armeniaca plant samples collected only in the northern extension of the mineralised ground. 15 samples were taken from stem, leaf and fruit of P. armeniaca plant samples in the study area (Figure 1 and 3). The samples taken were first washed with tap water, then with pure water. The plant samples dryed at room temperature were than dehydrated by keeping in the oven at 80-90^{0}C for 24 hours. 4-5gr was taken from each part of the dried plant samples and this samples put in the oven were ashed by burning up to 550^{0}C increasing the heat 50^{0}C per hour starting from 50^{0}C (Figure 3). Former researchers determined this heat range as 550^{0}C [15].

Figure 3. (a) P. armeniaca grown around and in the Gorgu Pb–Zn Deposit, and (b) (fruit), (c) (stem) a photograph from the ash operation of the plants

Soil Samples: 15 soil samples were taken from the soil on which P. armeniaca samples grew. The soil samples were taken from a location of 15-25cm deep where the roots of P. armeniaca plant exist. The soil samples taken to the laboratory. This samples were dried at room temperature for about 2 weeks (Figure 4).

Figure 4. A photograph from the drying operation of the soils

Soil and ash samples were digested for an hour at 95^{0}C by using the mixture of $HCl-HNO_3-H_2O$ (6ml of the mixture of 1/1/1 was used per 1.0g). Then the soil and ash samples were analyzed by 1:1:1 Aqua Regina digestion. 44 elements analysis in the soil and plant samples were done by ICP-MS (Inductively Coupled Plasma-Mass Spectrophotometer) at ACME analytical laboratories.

4. RESULTS AND DISCUSSION

In soils, Cd, Cr, Cu, Ni, Pb and Zn values range between 1mg/kg and 650mg/kg, whereas Fe and Mn can rise 10% and 20mg/kg, respectively [16]. All heavy metals above of 1000mg/kg in the soil (except Fe) are toxic to plants. Therefore, changes the structure of the plants if metal pollution in the area of the plant. But, each plant species should have a specific toxic threshold value for heavy metals in each region [17 and 18]. Table 1 shows element analytical results of soil samples on which P. armeniaca grew. The analysis of metals in soil samples yielded the following metal ranges: Cd from 0.11 to 123mg/kg (mean 31.47); Cr from 62 to 394 (mean 145.6); Cu from 24 to 55 (mean 33.47); Ni from 68 to 104 (mean 86.4); Pb from 170 to >10000 (mean

4330.3); Zn from 174 to >10000 (mean 4009.9); Mn from 618 to 1661 (mean 1159.9) mg/kg and Fe from 2 to 5.7 (mean 4.3) % of soil. In the study area is high the concentrations of Pb, Zn and Mn values in soil in some of the sample locations (Table 1).

Table 1. Descriptive statistics for geochemical data in the soils (Ag, Au: µg/kg; Fe, K, Mg, Na, P, S: %; other elements mg/kg)

Soil	Minimum	Maximum	Mean	Median	Stadart Deviation	Skewness	Kurtosis	Range
Ag	64	4409	1380.8	361	1699.66	1.02	-0.76	4345
Al	2	2.94	2.37	2.2	0.33	0.55	-1.21	0.94
As	7	17	10.2	10	2.81	1.28	1.45	10
Au	0.5	4.1	2.24	2.1	1.12	0.08	-1.16	3.6
Ba	0.01	1399	476.2	243	521.4	0.62	-1.26	1399
Bi	0.14	0.23	0.19	0.17	0.03	0.22	-1.41	0.09
Be	0.7	1.4	1.03	1	0.21	0.33	-0.92	0.7
Ca	1	13	4.67	2.9	3.53	1.24	0.72	12
Cd	0.11	123	31.47	3.39	44.64	1.08	-0.52	122.9
Ce	25	56	36.2	34	8.71	1.28	1.23	31
Co	16	30	24.6	25	4.15	-0.49	-0.29	14
Cr	62	394	145.6	75	110.9	1.16	0.12	332
Cs	0.52	1.22	0.712	0.67	0.18	1.70	3.65	0.7
Cu	24	55	33.47	33	7.46	1.82	4.46	31
Fe	2	5.7	4.33	4.2	1.07	-0.61	-0.01	3.7
Ga	4.8	7.9	6.51	6.6	0.88	-0.03	-0.15	3.1
Hf	0.04	0.1	0.09	0.1	0.02	-2.12	5.02	0.06
Hg	15	43	26.6	25	7.60	0.75	0.42	28
K	0.24	0.46	0.34	0.32	0.07	0.29	-1.35	0.22
La	12.3	79.2	34.68	15.5	27.04	0.65	-1.56	66.9
Li	10.2	18	13.71	13.8	2.36	0.19	-0.89	7.8
Mg	0.56	0.98	0.76	0.73	0.14	0.34	-0.88	0.42
Mn	618	1661	1159.9	1153	290.49	-0.06	-0.29	1043
Mo	0.58	4.1	1.39	1	0.93	2.05	4.64	3.52
Na	0.00	0.01	0.00	0.00	0.00	0.81	0.71	0.00
Nb	0.25	0.68	0.42	0.37	0.13	0.65	-0.48	0.43
Ni	68	104	86.40	84	10.54	0.03	-0.81	36
P	0.05	0.09	0.07	0.07	0.01	-0.29	-0.10	0.04
Pb	170	10000	4330.3	1879	4279.4	0.61	-1.68	9830
Rb	8.5	22	13.69	13.1	4.29	0.52	-0.86	13.5
S	0.02	0.3	0.06	0.03	0.07	2.91	9.29	0.28
Sb	0.03	19	6.66	0.3	8.35	0.58	-1.76	18.97
Sc	3.3	7.4	5.85	5.9	1.05	-0.84	1.14	4.1
Se	0.3	1.6	0.67	0.4	0.45	1.16	-0.35	1.3
Sn	0.6	1.1	0.74	0.7	0.13	1.61	3.45	0.5
Sr	23	105	47.07	42	20.49	1.64	3.74	82
Th	1	10.3	3.86	3.1	2.21	2.11	5.11	9.3
Ti	0.01	20	8.01	0.02	10.14	0.46	-2.09	19.99
Tl	0.12	2.5	0.68	0.37	0.69	1.64	2.18	2.38
U	0.3	2.1	0.84	0.6	0.54	1.38	0.94	1.8
V	43	82	63.93	63	9.18	-0.22	1.26	39
Y	10.48	25.38	17.81	16.17	4.63	-0.04	-1.29	14.9
Zn	174	10000	4009.9	1587	4428.34	0.71	-1.63	9826
Zr	2.3	5.9	3.69	3.6	1.00	0.76	0.07	3.6

The permissible limit of Cr and Ni for plants recommended by WHO is 1.30mg/kg and 10mg/kg, respectively [4]. In plant P. armeniaca concentration of Cr and Ni were below the permissible limit (Table 2-4).

Table 2. Descriptive statistics for geochemical data in the stem samples (Ag, Au: µg/kg; Fe, K, Mg, Na, P, S:%; other elements mg/kg)

Stem	Minimum	Maximum	Mean	Median	Stadart Deviation	Skewness	Kurtosis	Range
Ag	2	11	5.2	5	3.10	0.50	-0.97	9
Al	0.002	0.01	0.01	0.01	0.002	-3.87	15	0.008
As	0.02	0.1	0.06	0.06	0.02	0.15	-0.26	0.08
Au	0	0.6	0.39	0.4	0.18	-0.53	0.12	0.6
Ba	5	206	46.07	20	54.41	2.21	4.99	201
Bi	0.002	0.005	0.003	0.003	0.00	0.41	-0.75	0.003
Be	0.01	0.03	0.02	0.01	0.01	0.80	-0.13	0.02
Ca	1.18	3.7	2.36	2.16	0.72	0.50	-0.31	2.52
Cd	0.04	1.01	0.33	0.21	0.31	1.42	0.90	0.97
Ce	0.04	0.26	0.14	0.12	0.07	0.36	-1.13	0.22
Co	0.01	0.08	0.05	0.05	0.02	-0.72	1.29	0.07
Cr	0.13	0.32	0.23	0.21	0.07	0.15	-1.42	0.19
Cs	0.003	0.018	0.01	0.007	0.004	1.85	4.95	0.015
Cu	1.65	33.44	5.28	3.19	7.99	3.57	13.21	31.79
Fe	0.0004	0.013	0.01	0.005	0.00	0.65	-0.31	0.013
Ga	0.02	0.04	0.03	0.03	0.01	0.43	-1.55	0.02
Hf	0.0003	0.003	0.002	0.002	0.001	-0.03	-0.66	0.003
Hg	0.06	0.4	0.19	0.15	0.10	0.61	-0.69	0.34
K	0.12	0.51	0.26	0.23	0.10	1.20	1.60	0.39
La	0.02	0.14	0.08	0.07	0.04	0.36	-1.12	0.12
Li	0.04	0.36	0.10	0.08	0.08	3.27	11.79	0.32
Mg	0.05	0.16	0.08	0.07	0.03	2.36	6.81	0.11
Mn	6	21	10.53	9	3.94	1.50	2.50	15
Mo	0.02	0.09	0.05	0.05	0.02	0.61	-0.59	0.07
Na	0.001	0.004	0.003	0.003	0.001	0.07	-0.22	0.003
Nb	0.002	0.01	0.01	0.01	0.003	-2.43	4.55	0.008
Ni	0.2	0.5	0.30	0.3	0.10	0.49	-0.91	0.3
P	0.02	0.1	0.04	0.04	0.02	1.31	2.26	0.08
Pb	0.9	40.2	15.10	8.8	15.33	0.69	-1.33	39.3
Rb	0.56	2.49	1.60	1.57	0.52	0.13	0.24	1.93
S	0.01	0.04	0.02	0.02	0.01	0.34	-0.11	0.03
Sb	0.002	0.006	0.004	0.004	0.001	0.00	-0.98	0.004
Sc	0.01	0.03	0.02	0.02	0.01	-0.23	-0.97	0.02
Se	0.02	0.05	0.03	0.03	0.01	0.84	1.46	0.03
Sn	0	0.05	0.02	0.02	0.01	1.62	5.60	0.05
Sr	18	94	51.47	53	20.2	0.17	0.04	76
Th	0.002	0.02	0.01	0.01	0.01	0.19	-0.79	0.02
Ti	3	6	4.33	4	0.98	0.28	-0.65	3
Tl	0.003	0.01	0.01	0.01	0.00	-0.18	-2.24	0.007
U	0.002	0.011	0.01	0.004	0.00	0.51	-1.18	0.009
V	0.13	0.51	0.31	0.31	0.11	-0.05	-0.61	0.38
Y	0.01	0.1	0.05	0.04	0.03	0.35	-0.90	0.09
Zn	13	55	29	27	12.6	0.76	-0.25	42
Zr	0.01	0.08	0.04	0.04	0.02	0.23	-0.64	0.07

Table 3. Descriptive statistics for geochemical data in the leaf (Ag, Au: µg/kg; Fe, K, Mg, Na, P, S:%; other elements (mg/kg)

Leaf	Minimum	Maximum	Mean	Median	Stadart Deviation	Skewness	Kurtosis	Range
Ag	1	37	9.13	8	8.77	2.48	7.67	36
Al	0.01	0.03	0.02	0.02	0.01	0.55	-0.39	0.02
As	0.1	0.2	0.11	0.1	0.03	3.87	15	0.1
Au	0.1	2.2	0.48	0.3	0.60	2.31	4.91	2.1
Ba	8	129	50.47	33	40.12	1.10	-0.11	121
Bi	0	0.01	0.004	0.004	0.00	0.94	0.97	0.01
Be	0.01	0.02	0.01	0.01	0.01	0.46	-2.09	0.01
Ca	0.6	2.1	1.52	1.6	0.46	-0.60	-0.47	1.5
Cd	0.02	0.6	0.17	0.1	0.16	1.83	3.28	0.58
Ce	0.1	0.3	0.20	0.2	0.05	0	1.62	0.2
Co	0.04	0.1	0.10	0.1	0.02	-3.87	15	0.06
Cr	0.2	0.6	0.33	0.3	0.10	1.61	4.20	0.4
Cs	0.01	0.09	0.03	0.021	0.02	2.93	9.72	0.08
Cu	1.8	6.3	3.83	3.8	1.26	-0.02	-0.10	4.5
Fe	0.01	0.03	0.01	0.01	0.01	1.34	0.47	0.02
Ga	0.02	0.08	0.05	0.05	0.01	-0.23	1.16	0.06
Hf	0	0.01	0.002	0.002	0.00	1.65	4.03	0
Hg	0.1	1.6	0.29	0.2	0.38	3.26	11.27	1.5
K	1.05	2.42	1.58	1.39	0.45	0.86	-0.53	1.37
La	0.1	0.2	0.11	0.1	0.04	2.41	4.35	0.1
Li	0.2	1.4	0.75	0.6	0.46	0.34	-1.70	1.2
Mg	0.26	0.97	0.75	0.75	0.17	-1.53	3.84	0.71
Mn	22	50	32.87	32	7.91	0.72	-0.14	28
Mo	0.1	0.7	0.25	0.2	0.17	1.38	2.23	0.6
Na	0	0.01	0.003	0.002	0.00	0.99	-0.40	0
Nb	0.01	0.03	0.01	0.01	0.01	2.41	4.35	0.02
Ni	0.4	1.4	0.74	0.6	0.30	0.89	-0.04	1
P	0.05	0.26	0.09	0.075	0.05	3.45	12.68	0.21
Pb	2	80	13.73	11	18.89	3.49	12.93	78
Rb	3.46	29.5	10.37	8.25	6.85	1.78	3.51	26.04
S	0.03	0.13	0.06	0.06	0.02	1.37	2.70	0.1
Sb	0	0.01	0.004	0.004	0.00	1.25	1.16	0.01
Sc	0.01	0.05	0.03	0.02	0.01	0.72	-0.44	0.04
Se	0.01	0.08	0.04	0.03	0.02	0.94	0.70	0.07
Sn	0.01	0.07	0.03	0.02	0.02	1.18	0.53	0.06
Sr	8	36	22.67	25	8.57	-0.43	-0.94	28
Th	0.01	0.03	0.02	0.02	0.01	0	-0.179	0.02
Ti	9	20	13.60	13	3.09	0.62	0.48	11
Tl	0	0.01	0.01	0.005	0.00	-0.01	-2.09	0.01
U	0	0.01	0.01	0.007	0.00	1.6	3.95	0.01
V	0.21	0.48	0.32	0.28	0.09	0.84	-0.61	0.27
Y	0.04	0.11	0.06	0.05	0.02	2.26	6.45	0.07
Zn	14	144	44.33	35	31.22	2.56	7.89	130
Zr	2.4	4.9	3.7	3.6	0.82	-0.18	-0.88	2.5

Table 4. Descriptive statistics for geochemical data in the fruit (Ag, Au: µg/kg; Fe, K, Mg, Na, P, S:%; other elements (mg/kg)

Fruit	Minimum	Maximum	Mean	Median	Stadart Deviation	Skewness	Kurtosis	Range
Ag	2	14	6.8	5	5.45	0.57	-2.23	12
Al	0.003	0.006	0.004	0.003	0.00	0.88	-1.75	0.003
As	0.01	0.09	0.054	0.05	0.03	-0.30	-1.02	0.08
Au	0.1	0.8	0.5	0.6	0.29	-0.61	-1.60	0.7
Ba	1.5	10.5	5.06	4.4	3.30	1.32	2.87	9
Bi	0.002	0.02	0.01	0.003	0.01	1.98	3.97	0.013
Be	0.1	10.3	3	0.2	4.44	1.54	1.77	10.2
Ca	0.1	0.3	0.24	0.3	0.09	-1.26	0.31	0.2
Cd	0.01	0.32	0.12	0.06	0.13	1.23	0.66	0.31
Ce	0.04	0.08	0.056	0.04	0.02	0.61	-3.33	0.04
Co	0.03	0.11	0.066	0.06	0.03	0.38	-1.91	0.08
Cr	0.07	0.18	0.108	0.09	0.04	1.39	1.57	0.11
Cs	0.002	0.02	0.011	0.01	0.01	0.13	-2.99	0.018
Cu	1.8	8.7	5.68	6.4	2.56	-0.75	1.10	6.9
Fe	0.01	0.06	0.02	0.01	0.02	2.24	5.00	0.05
Ga	0.02	0.04	0.024	0.02	0.01	2.24	5.00	0.02
Hf	0.0002	0.0006	0.00048	0.0005	0.00	-1.74	3.25	0.0004
Hg	0.07	0.59	0.206	0.12	0.22	2.10	4.51	0.52
K	0.63	1.22	0.856	0.85	0.24	0.97	0.74	0.59
La	0.02	0.04	0.028	0.02	0.01	0.61	-3.33	0.02
Li	0.06	0.18	0.094	0.07	0.05	1.73	2.84	0.12
Mg	0.04	0.2	0.128	0.13	0.06	-0.55	0.63	0.16
Mn	3	10.1	7.14	7.2	2.81	-0.68	-0.15	7.1
Mo	0.02	0.1	0.064	0.05	0.04	0.03	-2.06	0.08
Na	0.0005	0.0017	0.0011	0.001	0.00	0.12	-1.90	0.0012
Nb	0.002	0.005	0.0032	0.003	0.00	0.54	-1.49	0.003
Ni	0.2	1	0.64	0.6	0.30	-0.55	0.87	0.8
P	0.1	0.3	0.22	0.2	0.08	-0.51	-0.61	0.2
Pb	1	7.5	3.48	2.2	2.60	1.10	0.35	6.5
Rb	4	21.9	12.1	12.5	7.07	0.35	-0.80	17.9
S	0.01	0.16	0.086	0.08	0.06	-0.06	0.68	0.15
Sb	0.001	0.003	0.002	0.002	0.00	0.00	2.00	0.002
Sc	0.007	0.016	0.0104	0.009	0.00	1.06	0.20	0.009
Se	0.01	0.06	0.03	0.02	0.02	0.58	-2.63	0.05
Sn	0.01	0.04	0.024	0.02	0.01	0.40	-0.18	0.03
Sr	0.9	4.3	2.98	3.4	1.39	-0.91	-0.31	3.4
Th	0.004	0.01	0.0088	0.01	0.00	-2.24	5.00	0.006
Ti	5	15	11.2	12	4.27	-0.74	-0.76	10
Tl	0.001	0.005	0.0028	0.003	0.00	0.55	0.87	0.004
U	0.001	0.004	0.0024	0.002	0.00	0.40	-0.18	0.003
V	0.1	0.3	0.2	0.2	0.07	0.00	2.00	0.2
Y	0.01	0.03	0.016	0.01	0.01	1.26	0.31	0.02
Zn	9	59	36.4	36	19.48	-0.40	-0.50	50
Zr	0.006	0.038	0.018	0.013	0.01	1.41	2.04	0.032

The permissible limit of copper for plants recommended by WHO is 10mg/kg [4 and 19]. In the stem of P. armeniaca concentration of Cu was found above the permissible limit while in its leaf and fruit concentration of Cu was below the permissible limit (Table 2 and 4). The permissible limit of Cd, Pb, Zn and Fe in plants recommended by WHO is 0.02mg/kg, 2mg/kg, 50mg/kg and 0.002%, respectively [4]. In the stem, leaf and fruit of P. armeniaca concentrations of Cd, Pb, Zn and Fe were found above the permissible limit (Table 2 and 4).

Sperman Correlation Coefficients (r) are among experimental findings (of this study) Ag soil/Ag leaf (r=0.71, n=15, p<0.01, %99 reliability), Ag soil/Ag stem (r=0.63, n=15, p<0.05, %95 reliability), Fe soil/Fe leaf (r=0.68, n=15, p<0.01, %99 reliability), Pb soil/Pb leaf (r=0.69, n=15, p<0.01, %99 reliability), Pb soil/Pb stem (r=0.72, n=15, p<0.01, %9 reliability), Zn soil/Zn leaf (r=0.74, n=15, p<0.01, %99 reliability), Zn soil/Zn stem (r=0.62, n=15, p<0.05, %95 reliability), Be soil/Be leaf (r=0.62, n=15, p<0.05, %95 reliability), Se soil/Se leaf (r=0.67, n=15, p<0.01, %99 reliability) P. armeniaca plants are important depending on the sample quantity. It was determined that the stem of P. armeniaca plant for Ag and Zn and leaf for me do not signify anything statistically (%95 reliability, P<0.05). In biogeochemical prospect, it could be suggested that the leaf of P. armeniaca plant for Ag, Fe, Pb, Zn and Se, and the stem for Pb can be used to determine the indicator plants.

Besides, since in parallel with too much amount of Ag, Fe, Pb, Se and Zn in soil P. armeniaca plant includes too much amount of Ag, Cd, Cu, Mn, Pb and Zn, this plant type could be said to be an accumulator plant. The metal value changes depending on the distance of the stem, leaf and fruit samples of the P. armeniaca plant taken from the study area is observed in Figure 5 and 7. 1-3 number samples were taken from surroundings of the mining area, 4-6 number samples from the mining area, 9-14 number samples between the mining area and the highway and 15 number samples from the furthest point to the highway.

The Ag and Cd values, Pb and Zn values and Cu and Mn values in the soil have the similar distribution from the number one sample to the number 15 sample. Ag, Cd, Cu, Mn, Pb and Zn values show a distribution parallel to each other. In the element values a regular decrease is seen of the P. armeniaca plant fruit taken from the surroundings of the mining area as it becomes more distant from the study area that is as gets close to the highway. In the other words, these elements increase as it gets closer to the mining area. For this reason, this plant can be used for the rehabilitation of areas contaminated by Ag, Cd, Cu, Mn, Pb and Zn. However, in the simple of the number 11 fruit sample, a slight increase was observed. Since the area where the mine is located in higher codes topographically, minerals having these elements could have been moved to the number 14 and 15 locations.

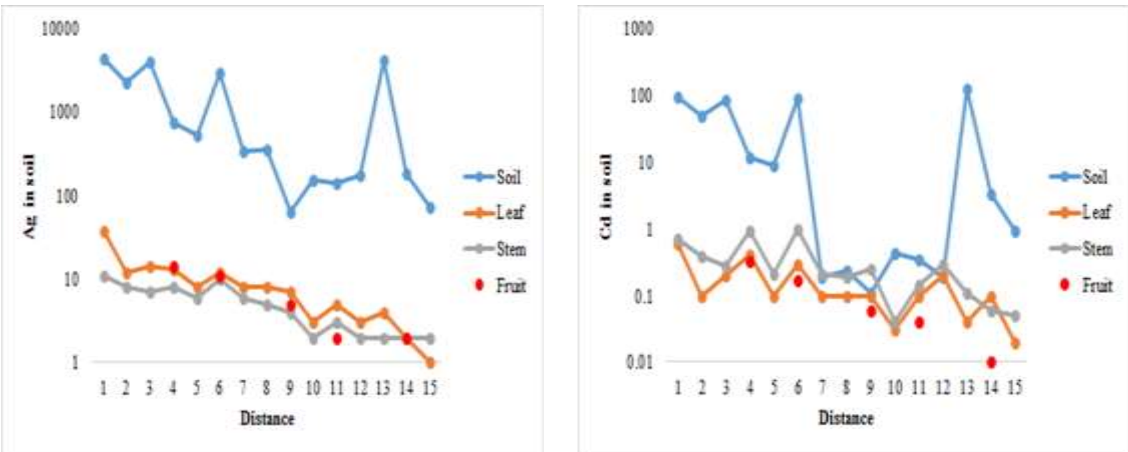

Figure 5. Distributions according to distance of Ag (µg/kg) and Cd (mg/kg) elements

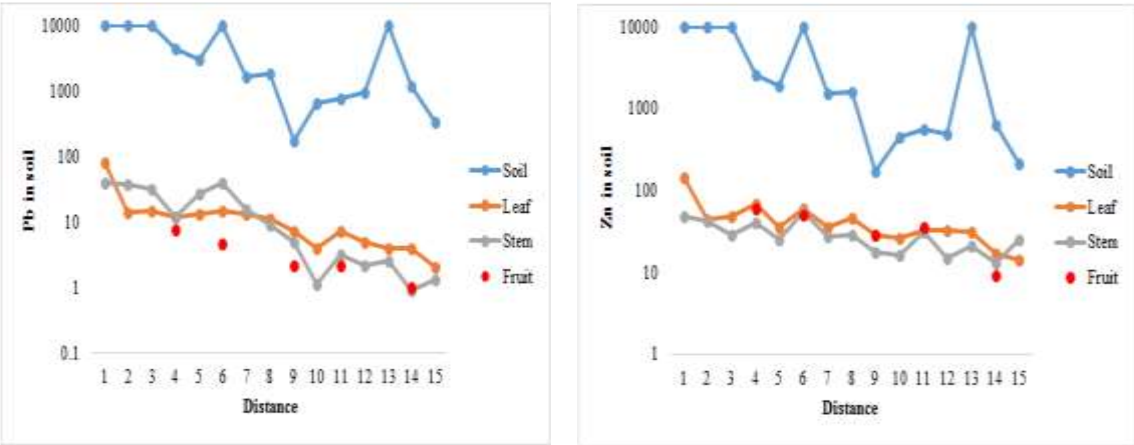

Figure 6. Distributions according to distance of Pb and Zn elements (mg/kg)

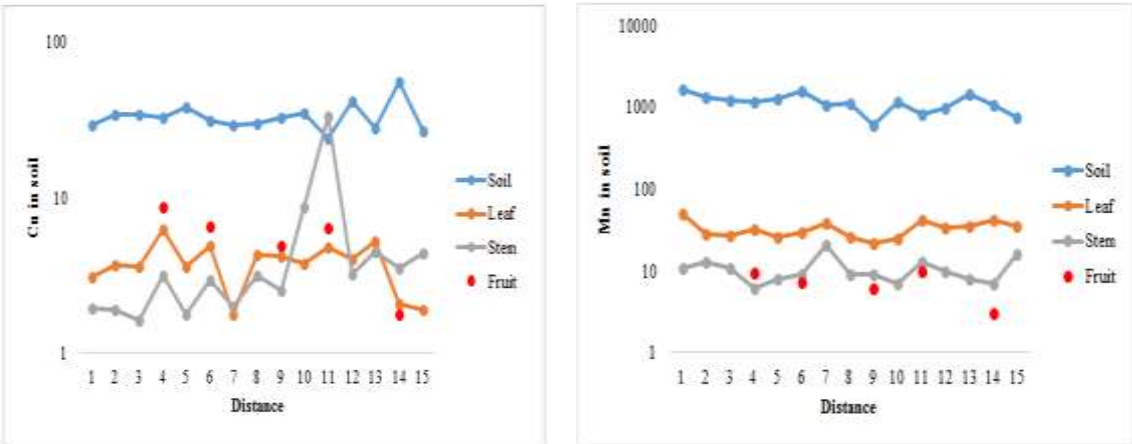

Figure 7. Distributions according to distance of Cu and Mn elements (mg/kg)

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NOTICE

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