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The physical and chemical characteristics of vineyard soils and its heavy metal content in semi-arid environments

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Turkey is one of the most important seedless raisin producers in the world market. Approximately, 82% of the seedless raisin has been produced in Aegean Region of Turkey and 25% of it has been produced in the Plain of Alasehir, located in Aegean Region. Therefore, the Plain of Alasehir was selected to study the physical and chemical characteristics, and the heavy metal contents of the vineyard soils. Hence, the soil samples were collected from 26 different locations in 13 different vineyards to analyze the macro and micro elements, such as total N (TN), P, K, Ca, Mg, Fe, Zn, Mn, and Cu and, the total heavy metal contents, such as Fe, Zn, Mn, Cu, Ni, Co, Pb, Cd, and Cr. Results showed that the soil samples were moderately alkaline. The salinity was suitable to grow seedless grape. The soil textures were either lime or sandy-loam with poor organic matter content. TN, P, Ca, and Mg concentrations were sufficient in the soil; however, 38.5 % of the samples were insufficient for K content. Similarly, Mn and Cu concentrations were sufficient while Fe and Zn were insufficient. Boron concentrations were high in 76.9% of the soil samples, which is a great concern for seedless grape production. Cd and Cr toxicity were not detected while Pb pollution was observed in only one vineyard. There was Co pollution in the 23.1% and %53.8 of the soil samples for the first and the second depth, respectively. Ni pollution was detected in some soil samples.

Key words: Vineyards (*Vitis vinifera* L.*),* macro elements, micro element, soil productivity, heavy metal, raisin.

INTRODUCTION

Substances or energies introduced into the environment that has undesired effects, or adversely effect of usefulness of a resource is called "pollutants". In general, pollutants are originated from domestic, industrial, and agricultural practices. One of the most harmful pollutants is the heavy metal based chemicals. Analysis of heavy metals in environmental samples caught the attention of researchers in the recent years, since they have toxic effects on living organisms. Removing the heavy metals from the soil is very hard and an expensive process.

The contamination level in soil has increased with industrial developments because of waste disposal from industrial facilities to environment including metals, heavy metal salts and some other hazardous chemicals. Heavy

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metals are microelements (trace elements) needed by animals and plants; however, those microelements can become toxic when they exist above certain limits (Alloway, 1990). Depending on the type of facilities, industrial wastes may contain Fe, Zn, Cu, Mn, B, Pb, Cd, Ni, Cr, and Co, which may cause contamination when accumulated in the soil. Fertilizers, pesticides, and hormones used in agricultural applications are the other sources of contaminants for soils (Forstner et al., 1991; Jaraush-Wehrheim et al., 2001; Elmaci et al., 2002). Thus, a complex movement of elements in the environment needs to be monitored continuously. Also, the uptake of heavy metals by plants depends on factors such as plant variety, species, plant part, age of organ or plant, growth period, stability to heavy metals, and transfer factor of heavy metals (Fergusson, 1990; Secer et al., 2002).

Among the other countries, Turkey is one of the leading countries for high quality seedless raisin production and exportation since western part of Turkey has semi-arid climate, which is suitable for seedless grape growing. Turkey has large amount of vineyard farms that produce a wide variety and high volume of seedless grape. Most of the grapes produced in the region are processed to produce raisin. About 82% of Turkey's seedless raisin is produced in the Gediz Basin, which is in the Aegean Region. The majority of seedless grape is grown in the vicinity of several cities in the region, such as Izmir, Denizli, and Manisa. Particularly, the Plain of Alasehir in Manisa area covers about 25% of, seedless raisin production of the entire Aegean Region. About 90% of the total production of vineyards in the Plain of Alasehir is the round type of seedless raisin (*Vitis vinifera* L.) (Aydin et al., 2007).

Soil, water, and air pollution which is defined as environmental pollution leads to contamination in agricultural areas and also have negative impact on the quality and quantity of plant production. Moreover, this issue has threatening effects on human health as part of their food chain. Wrong agricultural practices in the region to increase the size, endurance, and quality of grapes have caused undesirable conditions in some of the vineyard soils. This issue also had negative impact on foreign market over the years.

Considering the Plain of Alasehir's seedless raisin production potential, maintaining the high quality of soil in vineyards gained attention in the region to increase the quality and the volume of raisin production. Therefore, the soil samples were collected from 26 different locations in 13 different vineyards to analyze the macro and micro elements, such as total N (TN), P, K, Ca, Mg, Fe, Zn, Mn, and Cu and the total heavy metal contents, such as Fe, Zn, Mn, Cu, Ni, Co, Pb, Cd, and Cr.

MATERIALS AND METHODS

In this study, 26 soil samples were collected from 13 vineyards (*Vitis vinifera* L.) during the verasion period in August 2009 from the Plain of Alasehir in Aegean Region, Turkey. Locations of the samples are presented in Table 1. The soil samples were collected from two different depths, which were 0 to 30 cm and 30 to 60 cm to analyze the total heavy metal contents, which were Fe, Zn, Mn, Cu, Ni, Co, Pb, Cd, and Cr and some of the macro and micro elements, which were total N, available P, K, Ca, Mg, Fe, Zn, Mn, and Cu. According to the new soil taxonomy system, the type of soils in this study can be classified as typical xerofluent soils (Altinbas et al., 1994).

The soil samples were prepared according to Anonymous (1951), pH analysis was made according to Jackson (1967), lime analyzed according to Schlichting and Blume (1966), total soluble salt to Anonymous (1951), soil structure to Bouyoucos (1962), the amount of organic C that was determined by method of wet burning organic matter by multiplying 1.724 factor to Reuterberg and Kremkus (1951), total N, with the modified macro Kjeldahl method to Bremner (1965), available P to Bingham (1949) and it was classified to Guner (1968). Available Fe, Zn, Mn and Cu, following the methods of DTPA-TEA and using an Atomic Absorbsion Spectrophotometre to Lindsay and Norvell (1978), available B was determined using colorimetric method to Riehm (1957). Furthermore, the total N content of the soils was analyzed using a modified Kjeldal method according to Bremner (1965) and the soil classification was done according to Kovanci (1985). Available K, Ca and Mg, were extracted in 1N NH_4OAC and K and Ca concentrations were determined using flame spectrophotometric method while Mg was determined using an atomic absorption spectrometer (AAS) (Pratt, 1965) and classification was done according to the Loue (1968). Total heavy metal and micro element contents (Cd, Co, Cr, Ni, Pb, Fe, Zn, Mn, Cu) were extracted using the aqua regia extraction method prior to analyzing using an AAS method (Slawin, 1968; Kick et al., 1980).

RESULTS AND DISCUSSION

Some physical characteristics, total N and available macro and micro element contents of soils

The soil samples were collected from the vineyards in the Plain of Alasehir in Aegean Region. The results of total soluble salt in water, pH, $CaCO_3$, texture, percentages of sand, silt, clay, and organic matter are presented in Table 2. Total N and available macro and micro element contents (P, K, Ca, Mg, Fe, Zn, Mn, Cu, and B) were presented in Table 3. When pH results were classified according to Kelogg (1952), 76.9% of soil samples collected from 0 to 30 cm depth were light alkaline (pH of 7.4-7.8) and 23.1% of the soil samples were medium alkaline (pH of 7.9-8.4). For the samples collected from 30 to 60 cm depth, 69.2% of the samples were light alkaline and 30.8% were medium alkaline. Therefore, the majority of the soil samples, which displayed light alkaline properties, were suitable for viticulture. In terms of total soluble salt content in the soil samples collected from both depths, about 7.7% of the samples were determined as light salty (0.15 to 0.35%) while about 92.3% of the soil sample were determined as very low salty (>0.15%), which was not toxic to the grape production (Anonymous, 1951).

Results for the samples collected from the depth of 0 to lime soil (2.5 to 5.0% lime), 30.8% of the samples were

Table 1. Soil samples locations.

Sample no.	Vineyard location	Name of the owner
1	Kovalık	Mehmet Ok
2	Mezarlık	Mustafa Onal
3	Saglık ocagı	Mehmet Aktaş
4	Kovalık	Ahmet Yildirim
5	Sellik	Suleyman Ceylan
6	Plain of Alasehir	Cevdet Yavuz
7	Plain of Alasehir	Huseyin Basturk
8	Plain of Alasehir	Suleyman Basturk
9	Plain of Alasehir	Faruk Ozturk
10	Plain of Alasehir	Cengiz Ozturk
11	Plain of Alasehir	Izzet Cetin
12	Plain of Alasehir	Huseyin Topaloglu
13	Plain of Alasehir	Cengiz Sahin

texture + lime (20.0 to 50.0% texture + lime), and 7.7% of the samples were rich based on lime (5.0 to 10.0% lime). For the samples collected from the depth of 30 to 60 cm, 53.8% of the samples were lime, 23.1% of the samples were texture + lime, 15.4% of the samples were texture + marl (10.0 to 20.0% texture + marl), and 7.7% of the samples were poor based on lime (Evliya, 1960). Furthermore, about 76.9% of soil samples collected from both depths were sandy-loam, 15.4% of the samples were loam, and 7.7% of the samples were silt-loam texture (2.5% silt-load texture) (Table 2). Similarly, Celik (1998) reported that the sandy-loam texture is necessary for viticulture. The organic matter content of the soil samples were as follows: for the samples collected from 0 to 30 cm depth; 61.5% of the samples were poor in terms of humic (>2%), 38.5% of samples were consider as humic (2 to 4%), for the samples collected from 30 to 60 cm depth; 92.3% of the samples were poor in terms of humic except the sample collected location 11 was humic according to classification by Schaffer and Schachtschabel (1967). These results explained that organic matter content in second depth was lower than that of first depth (Table 2).

Total nitrogen (N) content of the soil samples collected from both depths were measured and results based on nitrogen content expressed that: for the first depth; 61.5% of soil samples were medium (0.05 to 0.10%), 30.8% of samples were suitable (0.10 to 0.15%), and 7.7% of samples were rich (>0.15%); for the second depth, 84.6% of samples were medium, 7.7% of samples were rich, and 7.7% of the samples, which was location 1, was poor (Kovanci, 1985). These results showed that the vineyard soils from both depths were either medium or rich in terms of nitrogen content (Table 3).

The results from phosphorous analyses, which were examined according to the criteria values given by Guner(1968), for the both depths showed that the available phosphorus content was suitable for grape production(>3.26 mg.kg^{-1}) in all the locations. In addition, available potassium (K) for the first depth reported as follows: 30.8% of the soil samples were rich (300 to 400 mg.kg^{-1}), 23.1% of the soil samples were suitable (200 to 300 mg.kg^{-1}), 23.1% of the soil samples were inadequate (<150 mg.kg^{-1}), 15.4% of the soil samples were poor (150 to 200 mg.kg^{-1}), and 7.7% of the soil samples were excessive (<400 mg.kg^{-1}), and available potassium for the second depth explained as; 38.5% of the soil samples were inadequate, 30.8% of the soil samples were adequate, 15.4% of soil samples were rich, and 15.4% of the soil samples were poor based on the classification by Fawzi and El-Fouly (1980). Results showed that available potassium contents in the soil samples collected in the first depth were higher than that of the second depth and Altinbas et al. (1994) and Yener et al. (2002) was also observed in the same situation for the samples collected from the vineyards in the same area.

Calcium (Ca) contents of the soils in both depths were analyzed according to the criteria values presented by Loue (1968). In terms of Ca content of the soil samples, the results can be summarized as follows: for the samples collected from 0 to 30 cm depth, 15.4% of the samples were excessive (>3571 mg.kg^{-1}), 46.2% of the samples were rich (2857 to 3571 mg.kg^{-1}), and 38.5% of the samples were in suitable level (2143 to 2857 mg.kg^{-1}); for the samples collected from 30-60 cm depth; 7.7% of the samples were excessive, 53.8% of the samples were rich, and 38.5% of the samples were in suitable level. Results proved that the amount of Ca in both depths were adequate and very close each other. Magnesium (Mg) contents of the soil samples were also analyzed. Results showed that 92.3% of the soil samples in both depths was very excessive in terms of Mg (>350 mg.kg^{-1}) except the sample in location 5 in second depth had slightly lower Mg compare to the Mg content in other locations according to Loue (1968). Literatures expressed that the magnesium level in the majority of vineyard soils

Table 2. Physical and chemical properties of soil samples collected from the Plain of Alasehir vineyards.

Sample no	Sampling depth (cm)	pH	Total soluble salt (%)	Soil type				Soil texture	Organic matter (%)
				Lime (%)	Sand (%)	Silt (%)	Clay (%)		
1	0-30	7.98	0.031	23.78	54.24	36.00	9.76	Sandy loam	1.81
	30-60	8.03	<0.030	21.37	60.24	34.00	5.76	Sandy loam	1.05
2	0-30	7.81	0.045	26.62	62.24	26.00	11.76	Sandy loam	1.77
	30-60	7.85	0.038	24.42	62.24	30.00	7.76	Sandy loam	1.58
3	0-30	7.72	0.048	22.51	60.24	28.00	11.76	Sandy loam	1.74
	30-60	7.76	0.032	19.59	54.24	30.00	15.76	Sandy loam	1.63
4	0-30	7.79	0.045	33.22	62.24	20.00	17.76	Sandy loam	2.10
	30-60	7.75	0.050	34.21	68.24	16.00	15.76	Sandy loam	1.93
5	0-30	7.98	<0.030	9.69	76.24	16.00	7.76	Sandy loam	1.29
	30-60	8.04	<0.030	11.57	68.24	26.00	5.76	Sandy loam	1.16
6	0-30	7.70	0.062	3.04	72.24	22.00	5.76	Sandy loam	1.93
	30-60	7.96	0.055	2.01	70.24	22.00	7.76	Sandy loam	1.06
7	0-30	7.93	0.048	3.59	62.24	28.00	9.76	Sandy loam	1.56
	30-60	7.98	0.060	3.55	62.24	32.00	5.76	Sandy loam	1.46
8	0-30	7.62	0.280	4.66	52.24	36.00	11.76	Loam	2.21
	30-60	7.74	0.330	4.70	44.24	44.00	11.76	Loam	1.91
9	0-30	7.56	0.085	4.18	34.24	58.00	7.76	Silt loam	2.81
	30-60	7.74	0.070	3.63	38.24	52.00	9.76	Silt loam	1.79
10	0-30	7.60	0.061	3.71	46.24	44.00	9.76	Loamy	2.66
	30-60	7.65	0.063	3.77	50.24	38.00	11.76	Loamy	1.54
11	0-30	7.51	0.098	2.84	56.24	38.00	5.76	Sandy loam	2.86
	30-60	7.67	0.096	2.53	60.24	34.00	5.76	Sandy loam	2.34
12	0-30	7.74	0.045	4.54	60.24	26.00	13.76	Sandy loam	1.55
	30-60	7.84	0.046	4.50	62.24	28.00	9.76	Sandy loam	1.39
13	0-30	7.55	0.140	3.16	54.24	40.00	5.76	Sandy loam	1.98
	30-60	7.70	0.170	3.19	58.24	34.00	7.76	Sandy loam	1.69
Average		7.78	0.080	10.95	58.16	32.23	9.61	-	1.80

in various regions of Turkey was sufficient (Danisman et al., 1983; Altinbas et al., 1994; Yener et al., 2002; Elmaci et al., 2002).

Microelements were analyzed in all the soil samples collected from both depths in the Plain of Alasehir vineyards (Table 3). Results showed that 15.4% of the soil samples collected from both depth was insufficient based on Fe level (2.5 to 4.5 $mg.kg^{-1}$) while 84.6% of the samples were sufficient (>4.5 $mg.kg^{-1}$). Zn results for the soil samples collected from the first depth showed that 76.9% of the samples were sufficient (>1 $mg.kg^{-1}$) and 23.1% of the samples were in critical level (0.5 to 1 ppm) while in second depth; 53.8% of the samples were sufficient, 30.8% of the samples were in critical level, and 15.4% of the samples were insufficient (>0.5 $mg.kg^{-1}$) based on the values given by Lindsay and Norwell (1978). High lime ($CaCO_3$) content with lack of available Fe and Zn was also observed in the soils as shown in Table 3.

Cu and Mn contents of all of the soils samples from both depths were in an adequate level (1 to 2 $mg.kg^{-1}$ available Mn; >0 to 2 $mg.kg^{-1}$ available Cu) according to Lindsay and Norwell (1978). Cu content of the samples were higher in 0 to 30 cm depth compare to the Cu content in 30 to 60 cm depth. Available boron (B) content was determined in both depths and 76.9% of the samples were found in toxic level for the vineyard plants (0.5 to 2.0 ppm) (Scheffer and Schacthschabel, 1989). Previous studies also found similar results for boron content in the vineyard soils in Kavaklidere, Alasehir area, which is a

Table 3. Total N and available macro and micro element contents of the soil samples collected from the vineyard plantations.

Sample no	Depth (cm)	Total N (%)	Available (mg.kg^{-1})								
			P	K	Ca	Mg	Fe	Cu	Zn	Mn	B
1	0-30	0.084	15.4	410	3775	480	3.12	2.93	0.70	14.4	0.20
	30-60	0.053	5.2	295	3345	520	2.86	2.23	0.64	9.8	0.24
2	0-30	0.095	9.9	125	3660	420	5.32	2.42	1.52	27.1	0.14
	30-60	0.078	9.1	85	3545	500	4.75	2.26	0.58	15.3	0.18
3	0-30	0.095	11.4	285	3490	480	5.63	2.02	0.88	14.6	0.16
	30-60	0.081	7.5	220	3490	440	5.54	1.20	0.56	11.3	0.16
4	0-30	0.101	7.5	370	3490	420	5.10	2.06	1.56	14.6	1.27
	30-60	0.079	7.4	360	3605	460	4.09	1.85	1.40	14.0	1.32
5	0-30	0.064	9.6	95	2860	360	3.08	3.94	0.54	13.4	1.50
	30-60	0.056	5.4	85	3035	300	2.77	1.37	0.46	12.2	1.75
6	0-30	0.095	9.6	115	2405	440	29.0	2.52	1.02	22.4	1.11
	30-60	0.053	3.9	95	2230	360	16.0	1.10	0.48	15.7	1.01
7	0-30	0.081	15.0	165	2860	580	24.2	2.26	1.32	17.3	1.04
	30-60	0.071	6.7	115	2750	580	18.9	1.49	0.86	12.4	1.05
8	0-30	0.115	18.1	390	2575	560	53.7	3.48	2.60	16.4	1.00
	30-60	0.081	13.7	155	3050	740	26.0	2.21	1.60	16.2	0.96
9	0-30	0.134	22.7	285	3100	440	48.0	3.72	1.88	14.7	1.08
	30-60	0.092	18.1	240	2700	500	35.2	3.17	1.30	18.2	1.16
10	0-30	0.134	20.5	230	2745	440	62.9	5.18	3.40	23.1	1.04
	30-60	0.062	10.9	155	2945	360	40.9	2.59	2.80	31.7	1.10
11	0-30	0.157	20.1	305	2745	400	70.8	6.86	3.20	22.4	1.22
	30-60	0.112	15.6	295	2405	280	31.2	2.47	1.46	12.4	1.14
12	0-30	0.084	14.8	190	2945	320	40.0	3.62	1.94	22.8	1.12
	30-60	0.076	11.8	135	2805	480	38.7	2.69	1.70	24.4	1.10
13	0-30	0.109	16.4	400	2700	460	26.0	2.74	1.90	17.8	1.18
	30-60	0.081	16.1	315	2750	380	27.1	2.04	1.16	12.9	1.25
Average		0.090	12.4	228	3,000	450	24.3	2.71	1.44	17.2	0.94

close area for the sample locations used in this study (Konuk and Yener, 1995; Yener et al., 2002). Boron content in irrigation waters was also found high in this area. One possible reason for high boron content in the irrigation water can be explained that the hot spring water resources located in the area cause increase in the boron content in the groundwater. Thus; we can state that boron is possible to become a problem in vineyards in the Plain of Alasehir in the near future.

Total micro elements and heavy metal contents of soil that is soluble in Aqua Regia

Minimum, maximum and average values of total micro elements and heavy metal (Fe, Zn, Cu, Cd, Co, Ni, Pb) contents of soil samples collected from vineyards plantations in both depths (0 to 30 cm and 30 to 60 cm) are presented in Table 4. According to Scheffer and Schachtschabel (1989), the limit values of Fe in soils in both depths were 0.5 to 5.0% of Fe, which were not toxic for vineyard soils. In terms of total Zn content, there was no Zn pollution risk in both depths in sampling locations since Zn values analyzed in this study were lower than the limit value of 300 mg.kg^{-1} given by Kloke (1980) for vineyard soils. Total Mn content in both depths were also under the limit values (1500 to 3000 mg.kg^{-1}) given by Pendias and Pendias (1992) for vineyard soils. Besides, it was noticeable that the amount of Mn in the samples found as well below the critical Mn limits. Furthermore, results from this study showed that the total Cu content which was extracted using the aqua regia ($3HCl+HNO_3$)

Table 4. Total micro elements and heavy metal contents of the soil samples collected from the vineyard plantations.

Sample no	Depth (cm)	Total Fe (%)	Total ($mg.kg^{-1}$)							
			Cu	Zn	Mn	Co	Pb	Cr	Cd	Ni
1	0-30	1.89	38.5	112.4	495.0	28.0	69.3	28.2	2.26	43.8
	30-60	1.91	34.8	65.9	522.5	25.4	48.9	27.3	1.93	41.0
2	0-30	1.89	33.6	73.6	481.3	27.1	124.7	23.0	2.04	36.6
	30-60	1.78	35.8	62.0	495.0	28.0	185.4	25.3	2.04	38.0
3	0-30	1.86	24.9	62.0	357.5	22.3	40.3	25.0	1.82	37.2
	30-60	1.65	22.4	46.5	275.0	23.6	41.4	23.9	1.93	34.6
4	0-30	1.65	23.6	81.4	440.0	25.4	34.9	27.6	2.37	37.6
	30-60	1.54	22.9	73.6	288.8	25.8	34.9	26.2	2.36	38.3
5	0-30	1.69	34.9	62.0	316.2	20.6	22.6	23.9	1.21	33.4
	30-60	2.29	27.5	58.1	343.7	21.9	29.6	24.4	1.27	37.2
6	0-30	1.89	3.01	73.6	398.8	20.6	17.2	31.6	0.66	45.3
	30-60	2.08	23.6	100.7	343.8	18.4	9.7	27.9	0.61	34.8
7	0-30	2.81	32.7	143.3	426.3	22.3	16.7	35.1	0.72	47.2
	30-60	2.53	29.6	93.0	398.8	21.9	15.6	26.0	1.05	41.2
8	0-30	2.88	34.9	108.5	440.0	22.8	18.3	35.1	0.66	53.8
	30-60	2.96	39.7	155.0	495.0	25.8	19.9	41.7	0.88	50.4
9	0-30	2.67	30.1	174.4	343.7	23.1	14.5	34.2	0.83	34.4
	30-60	3.28	37.1	162.7	440.0	25.8	18.3	42.8	0.99	52.7
10	0-30	2.91	39.3	104.6	440.0	24.1	16.7	37.7	0.88	48.4
	30-60	3.02	35.2	132.6	360.0	25.6	17.2	39.4	0.96	56.5
11	0-30	2.12	45.2	93.0	412.5	21.0	19.9	36.8	0.88	44.8
	30-60	2.79	34.5	96.9	398.0	25.4	19.4	37.1	0.77	46.3
12	0-30	2.72	39.5	135.6	522.5	23.2	18.8	35.4	0.83	55.5
	30-60	2.72	37.9	166.7	495.0	24.1	18.8	34.2	0.77	56.1
13	0-30	3.00	35.1	135.6	440.0	24.5	15.6	38.5	1.05	45.7
	30-60	2.83	30.7	155.0	398.8	21.9	14.5	26.5	0.66	40.8
Average		2.36	31.8	105.0	414.2	23.8	34.7	31.3	1.25	43.5

was well below the standard levels, which were explained as 100 $mg.kg^{-1}$ by Kloke (1980) and 60 to 125 $mg.kg^{-1}$ by Pendias and Pendias (1992) (Table 4).

Total Cu contents of the soils samples generally decreased from first depth to the second depth. Hakerlerler et al. (1994), Elmaci et al. (2002) and Tuna et al. (2005), studied heavy metal pollution in the soil samples in the same area as in this study and they found the similar results as in the case of this study for Fe, Zn, Mn, and Cu. Additionally, Cd was analyzed in the soil samples and a high value of Cd was determined in especially vineyards that were close to industrial areas where exhaust gases and chemical fertilizers (superphosphate) were observed distinctively. In general, Cd content in most of the vineyards was under the well below the standard levels (3 $mg.kg^{-1}$) presented by Kloke (1980) and Pendias and Pendias (1992). According to these criteria, it was determined that there was no Cd toxicity in vineyard soils in the Plain of Alaşehir. Moreover, Alloway (1990) and Altinbas et al. (1994) reported that Cd was more concentrated in upper soil layers and its mobility was more than that of Pb and Cu along the profile while it was shown a similar mobility with Ni and Zn. In terms of total Co; there was no Co pollution according to the critical value (50 $mg.kg^{-1}$) given by Kloke (1980) in soils from both depths. According to the critical values (25 to 50 $mg.kg^{-1}$) given by Pendias and Pendias (1992), Co pollution was determined as 23.1% of soils in the first depth and 53.8% of the soils in the second depth were contaminated with Co (Table 4).

Previous studies have shown that most of the soils in Germany contained 5 to 100 ppm Cr even though in some cases the concentrations went up to 300 ppm (Scheffer and Shachtschabel, 1989). Based on the values of 75 to 100 ppm Cr content given by Pendias and Pendias (1992) and 100 ppm Cr pollution given by Kloke (1980), there was no pollution concern in the region for this metal. While Pendias and Pendias (1992) reported the critical value for Ni in soils as 100 ppm, Kloke (1980) reported the critical value as 50 ppm for this metal. If we consider the 50 ppm Ni concentration as a critical value as reported by Kloke (1980), Ni pollution was determined in the 15.4% of soils at the first depth, and in 30.8% of soils at the second depth (Table 4). The amount of the Ni in the collected soil samples from both depths was close to the limit value (50 ppm), (Table 4). The total Ni in the agricultural soils was reported between 28.7 and 86.2 ppm from the Gediz region (Altinbas et al., 1994) and between 22.3 and 962.5 ppm in the Manisa and Menemen plain (Elmaci et al., 2002). Additional to agricultural and industrial practices that may cause pollution in the soils, the distance between agricultural areas and the highways are linked to the soil pollution in terms of Cd, Pb and Ni concentrations (Ndiokwere, 1984; Hakerlerler et al., 1994). Pb was detected between 1 and 20 ppm in slightly polluted soils and between 25 and 95 ppm in more polluted soils (Scheffer and Schachtschabel, 1989). Kloke (1980) reported that the critical value of Pb pollution was 100 ppm in soils. According to this critical value by Kloke (1980), there is a Pb pollution in 92.3% of the soils in both depths, except vineyard number 2. The source of Pb pollution can be the use of phosphorus fertilizer, Pb containing fuel and Pb transmitted with air movements.

Conclusion

The soil samples, which were collected from the Plain of Alasehir vineyards, were analyzed and results showed that; the alkalinity of the soils was ranged between light and medium and the salinity was at optimum level, which was not harmful for the grape production. The lime and sandy-loam texture were determined with poor organic matter content. All the soil samples were sufficient in terms of total N and available P. Furthermore, available Ca and Mg content in all the soil samples and K content in 61.5% of the soil samples were at sufficient level. Light and medium alkalinities with rich lime content in the soils indicate possible phosphorus fixation issue. In this regard it has been recommended that phosphorus fertilization could be applied to the band and 20 to 30 cm deep in vineyards located in the Plain of Alasehir. In terms of the micro element contents; while the Fe and Zn content level were not sufficient, in all of the vineyards available Mn and Cu contents were at sufficient level. Available boron content was found in high level which could create a toxicity problem in 76.9% of the soils. One possible source for high boron content in the soils can be explained as high boron content in the groundwater sources in the vineyard area. Therefore, the quality of irrigation water should be monitored continuously in the region.

The total micro element contents of the soil samples were examined in the aqua regia and results showed that there was no pollution in terms of total Fe, Zn, Mn and Cu contents. The heavy metal contents were also determined and found no Cd and Cr toxicities in the soils. It was also determined that there was no Pb pollution of 93.2% of the soil samples except the samples collected from vineyard number 2. Co pollution was determined in 23.1% of the soil samples in the first depth while 53.8% of the samples in the second depth. Similarly, Ni pollution was determined by 15.4% of the soil samples in the first depth while 30.8% of the samples in the second depth. While Co pollution might be caused by industrial facilities, Ni and Pb pollutions might be caused from exhaust gases from the vehicles in the area.

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