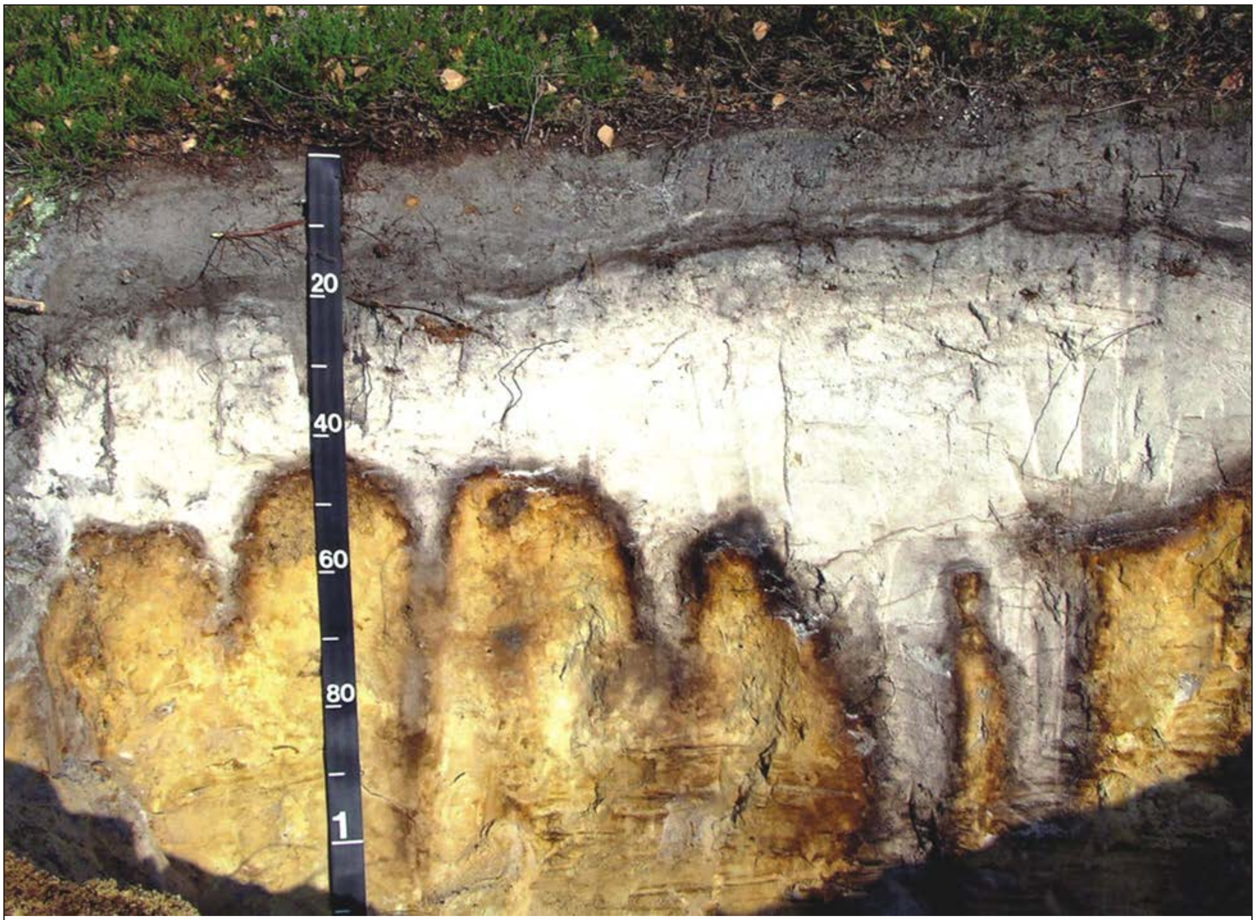

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Copper Correlation of Irrigation Water, Soils and Plants in the Cukurova Region of Turkey

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Abstract: In this study, copper content of soil and irrigation water and copper content of leaves and grain of wheat (*Triticum* spp.) were studied. Study samples of soil, leaf and grain were collected from wheat (*Triticum* spp.) fields in Cukurova Region of Turkey. Soil samples taken from the root area of plants where the leaf and grain samples were collected and analyzed for copper (Cu) content. The leaf samples taken during the stem elongation and the grain samples taken at the time of maturation were also analyzed for Cu content. The correlation analysis between soil-Cu contents and leaf and grain-Cu contents was performed to determine the relationships among the variables. The Cu content of the soil samples collected in 2005 was between 0.78 and 1.56 mg kg^{-1}. The Cu content of the soil samples collected in 2006 was between 1.12 and 1.96 mg kg^{-1}. The copper content of the majority of soil samples, collected in 2005 was observed above the critical level which is 1 mg kg^{-1}. The Cu content of the leaf samples was ranged from 26.30 to 67.60 mg kg^{-1} in 2005 and 3.06 to 18.02 mg kg^{-1} in 2006, whereas the copper content of the grain samples was ranged from 11.77 to 17.89 mg kg^{-1} in 2005 and 7.37 to 14.06 mg kg^{-1} in 2006. According to data analysis performed in collected samples, the Cu content of the leaf and grain samples was directly correlated with the Cu content of the soil. Correlation between copper content of soil and copper content of leaf in 2006 are significant at the 0.01 level based on the statistical analysis. Also, correlation between copper content of soil and weight of 1000 grain in 2005 and in 2006 are significant at the 0.01 level in respect of statistical analysis.

Key words: Soil characteristic, copper, micronutrient elements, copper deficiency

INTRODUCTION

The performed studies in recent years have showed the important role of micro elements in human and plant nourishment. The studies made especially on zinc point out that the problem of zinc deficiency is in serious condition in Turkey. Insufficient content of micronutrient elements in soil has a negative impact on the development of crops, which, in turn, affects human health. Micro element deficiencies like zinc and Fe bring out some serious health problems especially in children at developmental age. In this respect, micro nutrient elements exhibit a profound significance for the condition of human health as much as they do for a successful production of crops (Cakmak *et al*., 1997).

Micronutrients are mineral elements needed by plants in small quantities. It is very important for growers to have a clear understanding about micronutrient management. The lack of micro elements such as Mo and Cu in the environment where the plants are growing will prevent the nodule system from fixing significant quantities of N, even in the presence of effective strains of rhizobia (Mengel and Kirkby, 1987). Hallsworth *et al*. (1960) observed that there is a specific requirement for Cu in symbiotic N fixation and the absence of Cu markedly depressed nodule development and N fixation, where as leaf growth was only slightly reduced. Snowball *et al*. (1980) concluded that Cu is specifically required for N fixation, but evidence is still lacking as to the mechanism. In general, legumes need some micronutrients for their rhizobium activities. The level of Cu in soil solution decreases with increasing pH due to stronger adsorption (Lindsay, 1972). If the deficiency is due to pH imbalance, adding micronutrients can make matters worse because the level of individual micronutrients may affect the level of other micronutrients in the plant through antagonism. On the other hand, toxicity can occur when micronutrients are applied in excess (usually more than one application).

The objectives of this study was to determine the irrigation water copper content and the soil copper content of wheat production field in Cukurova region and to assess the effect of irrigation water copper content on Cu content of soils and effect of soil copper content on Cu content of leaf and grain.

MATERIALS AND METHODS

Description of the Area

This study was carried out in the Cukurova Region in 2005 and 2006 (Fig. 1). The study area is characterized by xeric climate and lies between 37°03' and 36°37' N latitudes and 35°12' and 36°02' E longitudes with altitude ranging between 20 and 80 m above MSL. The average amount of annual rainfall is 670.8 mm and potential total annual evaporation is about 1536.0 mm. The mean of annual air temperature and the mean of annual soil temperature at 50 cm depth are 19.1 and 20.8°C, respectively and all the soils are xeric. The vegetation in the study area is mainly grasses, cereal and leguminous crops. Wheat, cotton, maize, grape and soybean are the common crops in Cukurova Plain.

Methods

In this study, 23 leaves samples, 23 grain samples and 23 soil samples in 2005 and 30 leaves samples, 30 grain samples and 30 soil samples in 2006 were collected from wheat (*Triticum* spp.) fields in Cukurova Region of Turkey and those collected samples were analyzed for copper content. Also irrigation water and drainage water were sampled for micro element (Fe, Cu, Mn, Zn and B) analysis. The water samples were collected from ground water (1, 2, 3 number samples), drainage canal (number 4 samples), from seconder canal (number 5 samples), from primer canal (number 6 samples), from Seyhan River (number 7 samples), from down of old dam (numbers 8 sample), from upper of old dam (numbers 9 sample), from down of new dam (numbers 10 sample) and from upper of new dam (numbers 11 sample) for micro element analysis. Plant leaves were sampled during at the

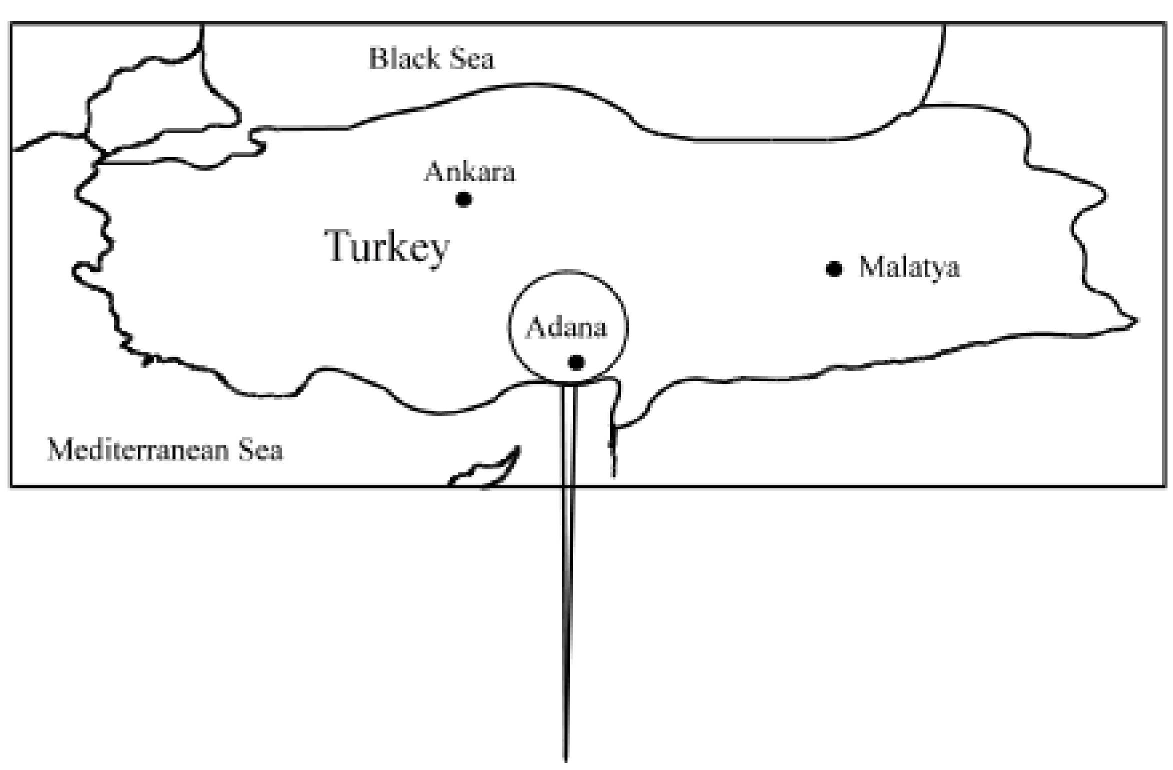

Fig. 1: Study Area in Çukurova Region

growing season (heading) and plant grain were sampled at the harvest time to determine the Cu content. Soil samples taken from the root areas of the plants for laboratory analysis were collected from 0-30 cm depth and air dried to pass a 2 mm sieve. The particle size distribution of each sample was determined by the pipette method (McKeague, 1978) after the removal of organic matter and carbonates. The pH on saturation extracts and organic C were measured using the Radiometer PHM 82 standard pH meter and a modified Walkley-Black procedure, respectively (Nelson and Sommers, 1996). Carbonate content was determined by applying the Scheibler calcimeter method (Black, 1965) and cation-exchange capacity was also assessed by Mg saturation followed by NH_4 substitution (McKeague, 1978). The methods characterized by Olsen *et al*. (1954) were used to determine the available P_2O_5. Extractable Cu oxides were analyzed by the citrate dithionite-bicarbonate method and total chemical analysis were carried out by the HF fussion method (Kick *et al*., 1980).

RESULTS AND DISCUSSION

Some Chemical Properties of Soil

The results of some chemical analysis of soil samples from 2005 were shown in Table 1. According to the results from analysis of soil samples collected in 2005, $CaCO_3$ and organic matter contents were observed between 12 and 20% and 1.32 and 2.70%, respectively. The CEC values changed between 21.32 and 34.76 cmol kg^{-1}. Soil pH changed between 7.50 and 7.99. Utilizable P_2O_5 content of soils collected in 2005 changed between 31 and 178 kg ha^{-1}. The maximum amount of utilizable P_2O_5 content was observed in sample 1 as 178 kg ha^{-1} appeared to be quite high, whereas the optimum amount of soil P_2O_5 content to provide favourable growing condition for plants is about 110 kg ha^{-1}. High P_2O_5 content may be attributed to excess application of nutrient to the soil. The excess amount of utilizable P_2O_5 content seems to have a disadvantage for micro elements uptake from soil (Cakmak *et al*., 1997; Long *et al*., 2004).

Table 1: Selected some physical and chemical properties of soils in 2005 (Irmak *et al*., 2008)

Sample No.	$CaCO_3$ (%)	Organic matter (%)	CEC (cmol kg^{-1})	pH 1/1	P_2O_5 (kg ha^{-1})	Particle size <2 mm (%) Silt	Sand	Clay
1	16	2.48	33.33	7.45	178	42.2	21.9	35.9
2	17	2.14	29.26	7.59	156	46.2	19.8	34.1
3	16	2.70	30.67	7.57	78	41.5	19.7	38.5
4	16	2.58	34.76	7.59	74	43.4	13.8	42.8
5	16	2.23	31.66	7.59	46	45.3	22.6	32.1
6	15	2.07	29.68	7.75	44	46.2	21.1	32.7
7	14	1.96	28.22	7.60	59	39.5	27.8	32.5
8	17	1.44	22.67	7.74	78	29.1	48.4	22.5
9	13	1.51	23.44	7.77	64	29.5	46.9	23.7
10	20	1.60	32.98	7.92	31	51.8	15.4	32.8
11	16	1.22	21.32	7.65	70	24.9	55.3	19.8
12	16	2.29	24.80	7.51	121	38.0	34.5	27.5
13	17	1.98	28.14	7.64	73	45.4	24.1	30.5
14	17	1.95	26.25	7.57	92	45.0	24.4	30.5
15	17	1.51	28.14	7.71	137	44.4	22.0	33.7
16	12	1.63	32.32	7.74	68	50.4	11.5	38.2
17	17	1.54	27.56	7.75	115	41.9	22.7	35.4
18	17	1.73	28.87	7.82	102	42.7	23.5	33.8
19	17	1.85	31.66	7.76	67	42.5	18.2	39.2
20	16	2.14	29.02	7.68	70	45.2	16.2	38.6
21	18	1.63	32.32	7.71	55	47.2	14.6	38.2
22	16	1.32	30.26	7.70	52	48.4	17.8	33.8
23	17	1.48	28.22	7.75	46	44.7	22.0	32.7

Table 2: Selected some physical and chemical properties of soils in study area in 2006 (Irmak *et al*., 2008)

Sample No.	$CaCO_3$ (%)	Organic matter (%)	CEC (cmol kg^{-1})	pH 1/1	P_2O_5 (kg ha^{-1})	Particle size <2 mm (%) Silt	Sand	Clay
1	16	2.33	26.04	7.50	125	43.0	25.1	31.9
2	17	2.05	28.66	7.64	49	46.1	22.8	31.1
3	16	2.02	29.77	7.71	51	44.8	24.6	30.6
4	16	1.83	25.04	7.58	130	41.9	25.9	32.2
5	16	1.71	29.63	7.62	70	43.7	23.1	33.2
6	16	1.49	21.24	7.57	179	25.3	51.6	23.1
7	19	1.90	38.02	7.69	64	49.2	16.4	34.4
8	21	1.83	30.62	7.75	68	45.9	21.9	32.2
9	18	1.73	32.22	7.76	47	48.7	10.5	40.8
10	21	1.90	30.83	7.73	65	49.7	11.6	38.7
11	19	2.08	30.87	7.68	25	51.7	11.2	37.1
12	18	2.08	29.94	7.71	66	52.3	10.6	37.1
13	18	2.14	30.91	7.74	38	47.9	12.6	39.5
14	17	2.24	35.50	7.64	122	48.6	11.2	40.2
15	18	2.21	33.08	7.71	122	49.7	11.2	39.1
16	18	1.96	34.75	7.66	74	49.2	11.7	39.1
17	18	2.17	36.33	7.65	69	48.2	11.0	40.8
18	18	1.74	34.72	7.76	66	48.9	9.7	41.4
19	18	1.99	33.08	7.68	81	49.3	11.1	39.6
20	17	1.99	33.55	7.72	105	50.5	12.3	37.2
21	18	1.90	33.80	7.71	49	48.3	10.0	41.7
22	18	1.86	33.66	7.77	56	47.5	10.7	41.8
23	19	1.99	30.88	7.74	16	48.2	12.8	39.0
24	21	2.05	30.80	7.72	72	50.6	14.7	34.7
25	20	1.71	33.30	7.67	60	48.9	13.8	37.3
26	21	1.46	31.72	7.63	29	53.7	7.9	38.4
27	21	1.65	31.63	7.50	46	50.5	14.4	35.1
28	21	1.27	31.51	7.59	60	52.0	11.6	36.4
29	18	1.65	32.60	7.99	51	47.2	16.7	36.1
30	17	1.68	31.60	7.72	31	44.0	19.9	36.1

Some selected physical and chemical properties of soil samples in 2006 were presented in Table 2. $CaCO_3$ and organic matter content of soil samples from 2006 were observed between 16 and 21% and 1.46 and 2.33%, respectively. The CEC values changed between 21.24 and 38.02 cmol kg^{-1} and the soil pH changed between 7.50 and 7.99. The lowest utilizable P_2O_5 content was observed in sample 23 as 16 kg ha^{-1} and the highest amount of utilizable P_2O_5 was 179 kg ha^{-1} in sample 6. It is believed that the excess amount of utilizable P_2O_5 in soil was caused by overdose application of fertilizer (Irmak *et al*., 2007).

Copper Content of Irrigation Water and Drainage Water

Copper contents of water samples collected in 2006 were shown in Table 5. Copper content of samples 1-3, which sampled from drainage waters, are 0.012 mg. Copper content of samples 4-6, which sampled from irrigation waters of canal, changed from 0.012 to 0.013 mg. Copper content of samples 7-9 which sampled from Seyhan river, changed from 0.011 to 0.013 mg. Copper content of samples 10-11, which sampled from Seyhan dam, are 0.010 mg. Copper content of Seyhan river water are relatively higher compared with the values of Seyhan dam waters. The high copper content of Seyhan river may be associated with domestic waste waters of Adana City. It is known that domestic waste waters of Adana City have been flowed into Seyhan river.

Copper Contents of Soil

Copper contents of soil samples collected in 2005 were shown in Table 3. Copper contents of soil samples, collected in 2005 were determined ranging from 0.78 to 1.56 mg kg^{-1}. Copper contents

Table 3: Copper content of soil, plant and grain in 2005

Sample No.	Copper ($mg\ kg^{-1}$) Soil	Leaf	Grain	1000 kernel (g)	Variety
1	1.40	37.00	12.26	48.94	Fuatbey-2000
2	1.44	35.80	14.69	46.15	Fuatbey-2000
3	1.34	26.30	15.15	50.61	Amanos-97
4	1.56	37.60	16.24	50.02	Amanos-97
5	1.26	35.30	16.25	43.46	Adana-99
6	1.20	37.40	15.69	39.71	Adana-99
7	1.24	53.50	14.90	40.15	Adana-99
8	0.78	39.20	11.77	39.86	Adana-99
9	0.94	34.80	13.86	43.00	Adana-99
10	0.96	37.30	14.79	40.20	Adana-99
11	0.84	38.90	14.86	41.38	Adana-99
12	1.20	39.20	14.61	43.60	Adana-99
13	1.20	45.40	13.90	44.85	Adana-99
14	1.06	44.20	15.40	43.76	Adana-99
15	1.12	41.00	14.74	40.15	Ceyhan-99
16	0.96	44.30	14.52	44.73	Ceyhan-99
17	1.12	40.30	17.89	41.00	Pandas
18	1.06	45.50	14.82	39.83	Pandas
19	1.08	67.60	13.78	42.76	Ceyhan-99
20	1.14	60.00	14.68	40.26	Pandas
21	0.86	39.20	17.47	41.40	-
22	0.78	44.70	17.32	43.16	-
23	0.92	45.70	15.93	42.85	-

of soil samples 8, 9, 10, 11, 16, 21, 22 and 23 were appeared to be lower than Cu critical level (1 $mg\ kg^{-1}$). Copper contents of other samples are higher than critical level which 1 $mg\ kg^{-1}$. The sample 8 had the lowest amount of copper content (0.78 $mg\ kg^{-1}$) and the sample 4 had the highest amount of copper content (1.56 $mg\ kg^{-1}$).

Results from copper analysis of soil samples from 2006 were shown in Table 4. Copper content of soil samples in 2006 was determined as high and ranged from 1.12 to 1.96 $mg\ kg^{-1}$. Copper contents of all samples are higher than critical level (1 $mg\ kg^{-1}$). The sample 6 had the lowest amount of copper content (1.12 $mg\ kg^{-1}$) and the sample 30 had the highest amount of copper content (1.96 $mg\ kg^{-1}$). The high copper content may be associated with chemical composition of parent material. It is known that soil parent material has an effect on chemical properties of soil (Irmak *et al*., 2007). Also, the high copper content of soils may be associated with irrigation waters from Seyhan River. It is known that Seyhan River has high copper content (Table 5).

Copper Contents of Leaves

Copper contents of leaf samples collected in 2005 were showed in Table 3. Copper contents of leaf samples were varied between 26.30 and 67.60 $mg\ kg^{-1}$. Copper contents of leaf sample 3 was determined as the lowest (26.30 $mg\ kg^{-1}$), On the other hands, copper content of sample 19 was determined as the highest (67.60 $mg\ kg^{-1}$). As seen in the study, copper contents of soil do have a direct effect on copper content of leaf except for samples 22 and 23. Correlations between copper contents of soils and copper contents of leaves in 2005 were shown in Fig. 2. Cakmak (1997), Fageria (2002), Calderini and Ortiz-Monasterio (2003) and Long (2004) reported that micro element contents of soils have some effect on the micro element content of leaves.

Copper contents of leaves collected in 2006 were shown in Table 4. Copper content of the leaf samples are changing between 3.06 and 18.02 $mg\ kg^{-1}$ in 2006 were relatively lower when compared with the values of 2005. Copper contents of leaf sample 7 was determined as the lowest (3.06 $mg\ kg^{-1}$). Also, copper content of sample 6 which has the lowest copper content soil was

Table 4: Copper content of soils, leaves and grains in 2006

Sample No.	Copper ($mg\ kg^{-1}$) Soil	Leaf	Grain	1000 kernel (g)	Variety
1	1.56	12.99	7.37	43.59	Adana-99
2	1.50	9.54	12.83	43.74	Ceyhan-99
3	1.36	7.66	10.37	40.14	Ceyhan-99
4	1.46	7.05	9.24	46.15	Adana-99
5	1.28	7.82	11.45	41.91	Adana-99
6	1.12	4.28	11.05	40.86	Adana-99
7	1.48	3.06	9.25	44.48	Adana-99
8	1.26	6.28	10.44	41.60	Adana-99
9	1.58	5.75	8.54	49.74	Fuatbey-2000
10	1.38	6.07	10.20	40.93	Pandas
11	1.34	9.05	11.52	40.07	Pandas
12	1.72	9.58	9.99	52.26	Fuatbey-2000
13	1.54	11.46	14.06	51.08	Amanos-97
14	1.66	12.73	11.16	40.87	Amanos-97
15	1.74	15.80	10.91	39.83	Adana-99
16	1.64	11.50	12.91	40.86	Ceyhan-99
17	1.68	13.29	8.45	42.12	Pandas
18	1.68	11.53	10.07	48.31	Fuatbey-2000
19	1.66	14.09	11.66	46.49	Amanos-97
20	1.82	18.02	11.98	41.44	Karatopak
21	1.70	8.15	9.79	45.07	Osmaniyem
22	1.74	9.78	11.37	44.30	Seri-2
23	1.40	10.99	10.64	37.30	Seri-2
24	1.30	12.85	10.66	34.83	Milan/Amsel
25	1.38	14.60	10.44	39.55	/Kauz
26	1.62	8.26	11.20	39.34	Adana-99
27	1.34	8.27	10.29	43.09	Fiscal
28	1.42	12.14	10.98	45.06	Fiscal
29	1.64	13.38	10.86	54.43	MexicalI.75
30	1.96	14.40	10.50	54.80	Amanos-97

Table 5: Some micro element contents of water samples

Sample No.	Cu	Fe	B (mg)	Zn	Mn
1	0.012	0.055	0.06	<0.013	<0.012
2	0.012	0.045	0.15	<0.013	<0.012
3	0.012	0.048	0.11	<0.013	<0.012
4	0.013	0.039	0.12	<0.013	<0.012
5	0.012	0.039	0.04	<0.013	<0.012
6	0.012	0.036	0.00	<0.013	<0.012
7	0.011	0.039	0.00	<0.013	<0.012
8	0.012	0.038	0.00	<0.013	<0.012
9	0.013	0.037	0.00	<0.013	<0.012
10	0.010	0.040	0.00	<0.013	<0.012
11	0.010	0.043	0.00	<0.013	<0.012

determined low (4.28 $mg\ kg^{-1}$). On the other hands, copper content of leave sample 20 was determined as the highest (18.02 $mg\ kg^{-1}$). Also, copper content of soil sample 20 was determined as the high (1.82 $mg\ kg^{-1}$).

The relation between copper content of soil and leaf in that condition might be explained by the uniformity of rainfall regime and higher amount of precipitation received during the intensive development stage of plants in 2006. On the other hands, moisturized soil during the development stage of plants decreases bio-utility of copper content in soil (Brooks, 1997; Kosuta *et al*., 2002; Morrell *et al*., 2003).

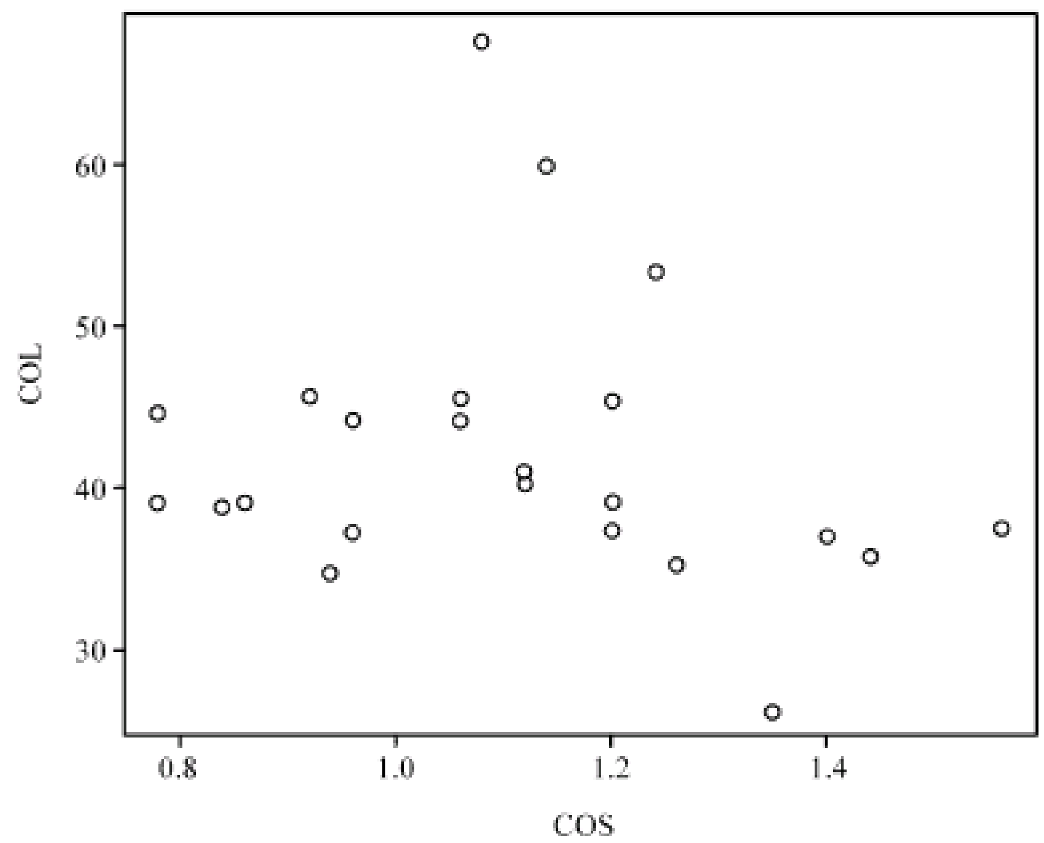

Fig. 2: Correlations between copper contents of soils and copper contents of leaves in 2005

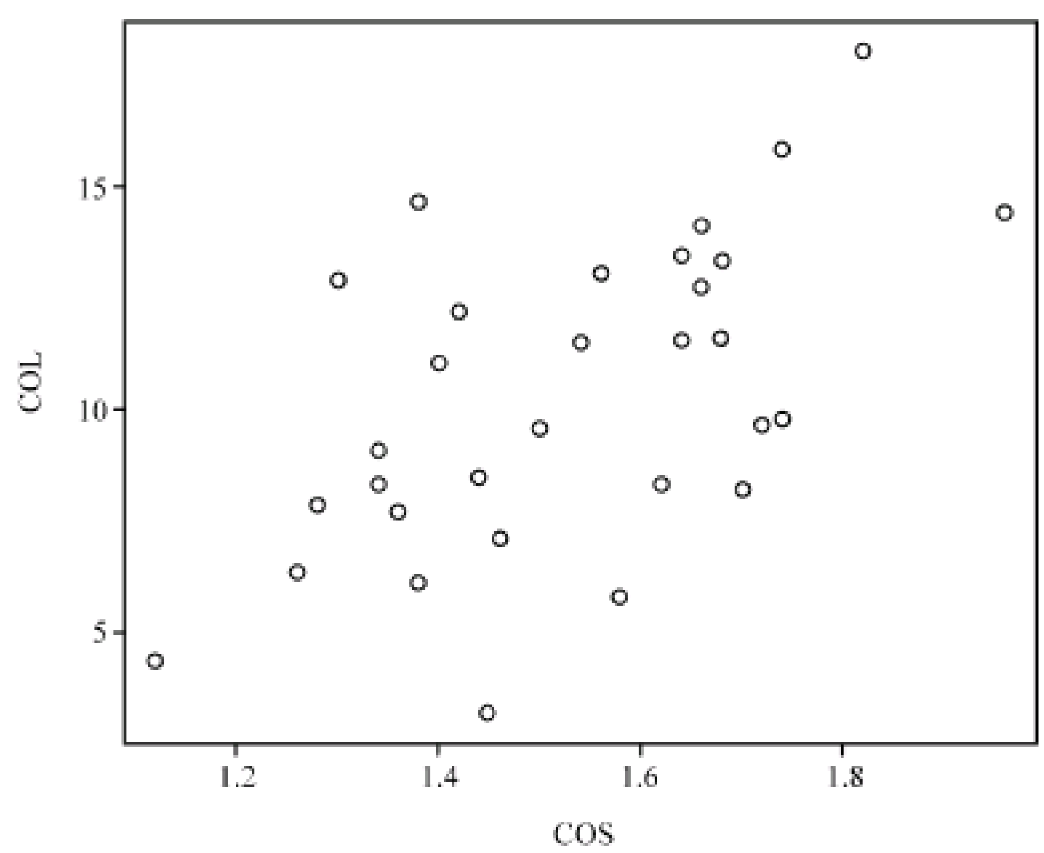

Fig. 3: Correlations between copper contents of soils and copper contents of leaves in 2006

Correlations between copper contents of soil and copper contents of leaves in 2006 were shown in Fig. 3. As seen in the study, copper contents of soil do have a direct effect on copper contents of leaves. Also, correlation between copper contents of soil and copper contents of leaves are significant at the 0.01 level according to statistical analysis (Table 4).

Copper Contents of Grains

Copper contents of grain samples collected in 2005 were shown in Table 3 and the amount of copper contents in grain samples changed between 11.77 and 17.89 mg kg^{-1} in 2005. Copper content of the grain samples in 2005 were relatively higher compared with the values of 2006. Grain sample 8 contained the lowest amount of copper and sample 17 contained the highest amount of copper. While

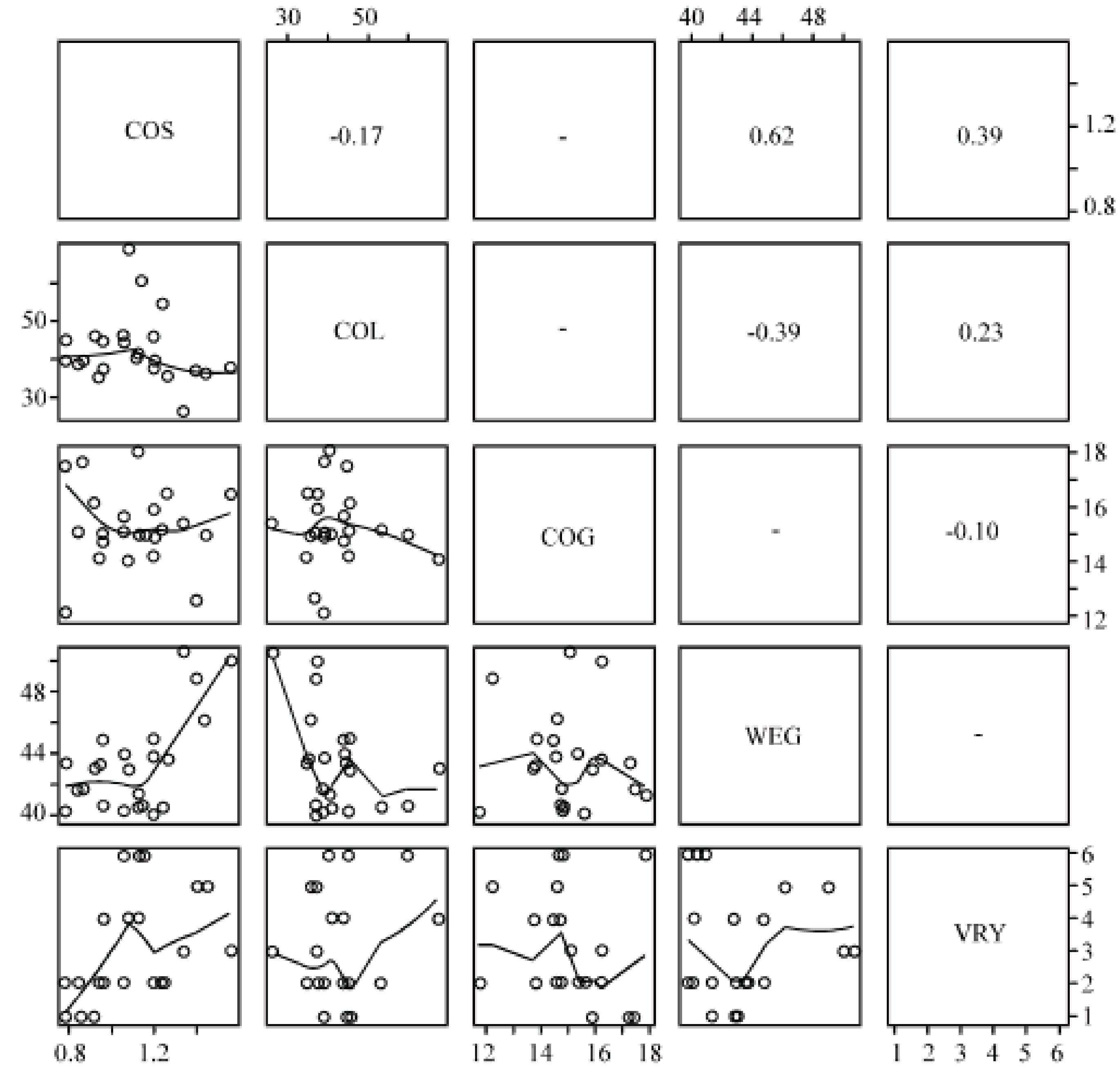

Fig. 4: Correlations between copper contents of soils, leaves and grain and weight of 1000 grain in 2005 according to statistical analysis

copper content of sample 8 was 11.77 mg kg^{-1}, copper content of sample 17 was 17.89 mg kg^{-1}. Copper content of soil sample 8 was determined as the lowest (0.78 mg kg^{-1}) and number 4 was the highest (16.24 mg kg^{-1}). Zhang *et al*. (1996) and Fageria *et al*. (2002) claimed that there was a direct relation between micro element content of soils and micro element content of grain. Correlation between copper contents of soils, leaves and grains were shown in Fig. 4.

Copper contents of the grain samples in 2006 changed from 7.37 to 14.06 mg kg^{-1} and the copper content in 2006 is relatively lower than the values of 2005. Grain sample 1 contained the lowest amount of copper and sample number 13 contained the highest amount of copper. Copper contents of grain samples collected in 2006 and the correlation between copper contents of soils, leaves and grains were shown in Fig. 4 and 5, respectively.

Correlation Between Copper Content of Soils and the 1000 Kernel

The weight of 1000 grain of samples in 2005 was shown in Table 3. The Cu contents of soils have affected the weight of 1000 grain except for some samples. There appears to be an inverse correlation between Cu content of soils and the weight of 1000 grain of Fuatbey-2000 variety. While the weight of 1000 grain of the sample number 1, which is Fuatbey-2000 variety, is 48.94 g, the weight of 1000 grain of the sample number 2 is 46.15 g. The Cu content of soil sample number 1 is 1.40 mg kg^{-1} and the Cu content of soil sample number 2 is 1.44 mg kg^{-1}. There are direct correlation between Cu content of soils and the weight of 1000 grain of Adana-99 variety. While the weight of 1000 grain of

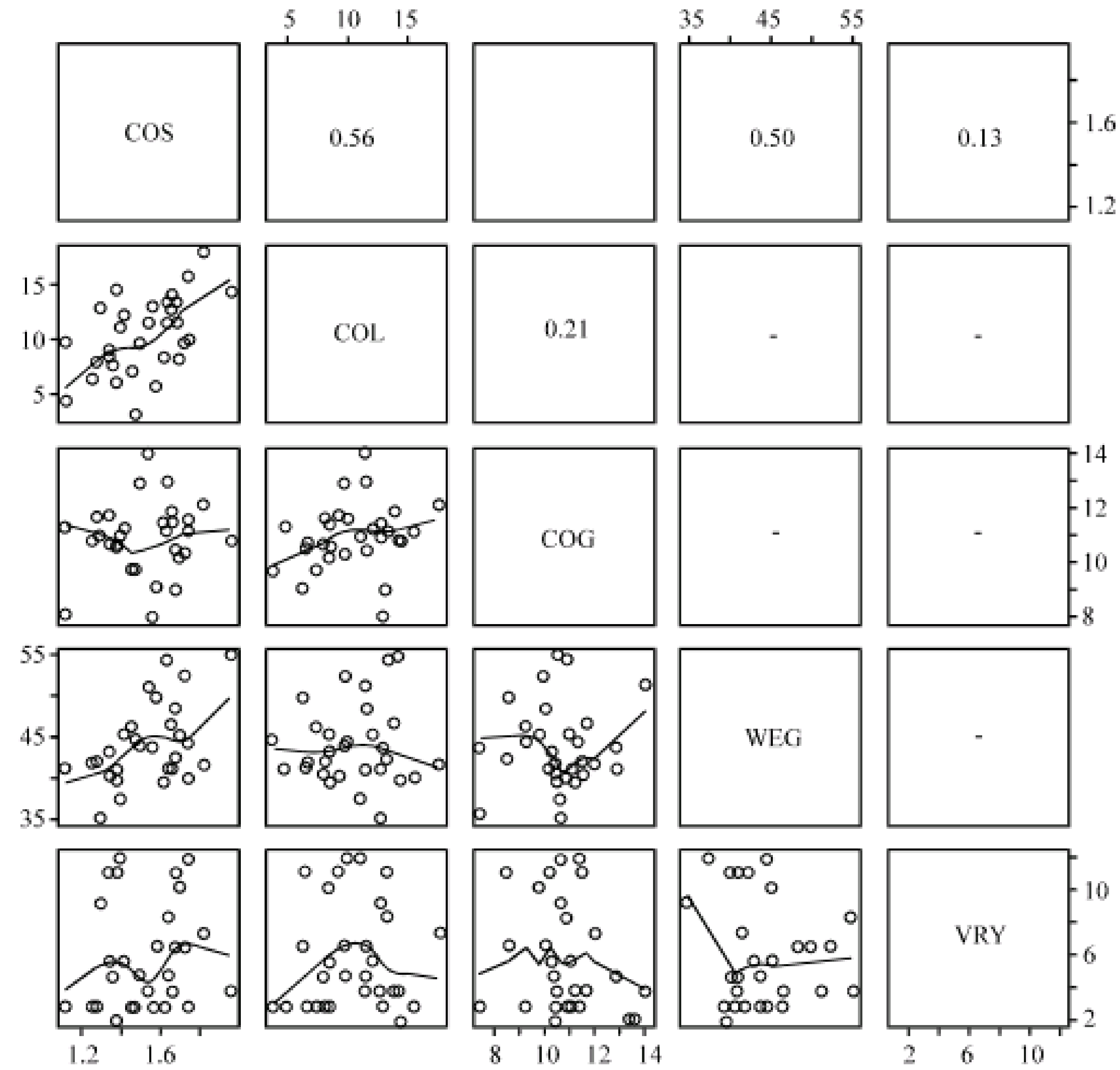

Fig. 5: Correlations between copper contents of soils, leaves and grain and weight of 1000 grain in 2006 according to statistical analysis

the sample number 8, which is Adana-99 variety, is 39.86 g, the weight of 1000 grain of the sample number 5 is 43.46 g. The Cu content of soil sample number 8 is 0.78 mg kg^{-1} and the Cu content of soil sample number 5 is 1.26 mg kg^{-1}. Also, the Cu content of grain of sample 8 is the lowest of all grain samples (11.77 mg kg^{-1}). There are inverse correlation between cu content of soils and the weight of 1000 grain of Ceyhan-99 variety. While the weight of 1000 grain of the sample number 15 is 40.15 g, the weight of 1000 grain of the sample number 16 is 44.73 g. Also, the Cu content of soil sample number 15 is 1.12 mg kg^{-1} and the Cu content of soil sample number 16 is 0.96 mg kg^{-1}. There are direct correlation between Cu content of soils and the weight of 1000 grain of Pandas variety. While the weight of 1000 grain of the sample number 18 is 39.83 g, the weight of 1000 grain of the sample number 17 is 41.00 g. The Cu content of soil sample number 18 is 1.06 mg kg^{-1} and the Cu content of soil sample number 17 is 1.12 mg kg^{-1}.

The weight of 1000 grain of samples in 2006 were shown in Table 4. The Cu contents of soils were affected the weight of 1000 grain except for some samples in 2006. There is a direct correlation between Cu content of soils and the weight of 1000 grain of Adana-99 variety. While the weight of 1000 grain of the sample number 6, which is Adana-99 variety, is 40.86 g, the weight of 1000 grain of the sample number 4 is 46.15 g. The Cu content of soil sample number 6 is 1.12 mg kg^{-1} and the Cu content of soil sample number 4 is 1.46 mg kg^{-1}. Also, there are inverse correlation between cu content of soils and the weight of 1000 grain of Ceyhan-99 variety. While the weight of 1000 grain of the sample number 16 is 40.86 g, the weight of 1000 grain of the sample number 2 is 43.74 g. Cu content of soil sample number 16 is 1.64 mg kg^{-1} and the Cu content of soil sample number 2 is 1.50 mg kg^{-1}. Also, there is an inverse correlation between cu content of soils and the weight of 1000 grain of Fuatbey 2000 variety in 2006. While the weight of 1000 grain of the sample number 9 which Fuatbey 2000 variety is 49.74 g, the weight of 1000 grain of the sample number 18 is 48.31 g. The Cu content of soil sample number 9 is 1.58 mg kg^{-1} and the Cu content of soil sample number 18 is 1.68 mg kg^{-1}.

Also, there are direct correlation between Cu content of soils and the weight of 1000 grain of Seri-2 and Fiscal varieties. While the weight of 1000 grain of the sample number 23 which variety Seri-2 is 37.30 g, the weight of 1000 grain of the sample number 22 is 44.30 g. The Cu content of soil sample number 23 is 1.40 mg kg^{-1} and the Cu content of soil sample number 22 is 1.74 mg kg^{-1}. While the weight of 1000 grain of the sample number 27 which variety Fiscal is 43.09 g, the weight of 1000 grain of the sample number 28 is 45.06 g. The Cu content of soil sample number 27 is 1.34 mg kg^{-1} and the Cu content of soil sample number 28 is 1.42 mg kg^{-1}.

According to these results varieties of Adana-99, Pandas, Seri-2 and Fiscal appear to be sensitive to copper element.

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