

Quality Assessments for Irrigation Waters used in Agricultural Fields of Konya - Meram Hatunsaray Neighborhood

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Abstract— This study was conducted to assess the quality of water samples taken from irrigation wells used for irrigating agricultural fields of Hatunsaray neighborhood of Meram district, Konya province. Within the scope of the study, water samples were collected from the wells used for irrigation and soil samples were also collected from the agricultural fields irrigated with these wells at depths of 0-30, 30-60 and 60-90 cm. Irrigation water and soil samples were subjected to physical and chemical analyses. Majority of the soils in the region were loamy (L) and clay-loam (CL) in texture. Soil pH values varied between 7.94 - 9.10 and soil EC values between 242 - 857 $\mu\text{mhos/cm}$. Irrigation water EC values ranged from 198 to 772 $\mu\text{mhos/cm}$, while the pH values ranged from 6.91 to 8.38. Irrigation water samples were classified as C₂S₁ (moderately saline - low alkaline). To prevent salinity problems in agricultural lands, drainage systems should be established and maintenance and repairs of existing drainage channels should be carried out periodically. It is anticipated that the necessary cultural measures will prevent salinity problems in the coming years.

Keywords— Irrigation, irrigation water quality, salinity, sodium content, soil salinity.

I. INTRODUCTION

Soil chemical properties play a great role in irrigated crops. Availability of different compounds in irrigation water is also largely dependent on soil properties. Salinity-induced soil loss of 10 million hectares annually serves as a dramatic example of soil-water quality interaction [1].

Water is the most important factor in agricultural production. Water and irrigation designate sustainable agricultural production especially in arid and semi-arid regions. Irrigation is the process of supplying the amount of water required by plants, which cannot be met by rainfall, to the plant root zone at proper time [2].

Water-air balance of the soil is disrupted when the balance between drainage and irrigation was not established. In such cases, soil air content decreases and yield losses are encountered then. Additionally, salinity and alkalinity issues arise. At the end, crop yields decrease or even cease entirely, depending on the levels of salinity and alkalinity. Soil must contain sufficient and appropriate levels of plant nutrients to achieve high-quality and abundant agricultural production. Excessive or insufficient levels of these nutrients negatively affect plant growth and development. Therefore, soil chemical and physical properties should be determined to solve problems encountered in agricultural production [3].

[4] indicated that besides irrigation method, timing and amount, irrigation water quality is also an important factor in modern irrigations. Unsuitable water is used in irrigation when sufficient and good-quality water is not available. Such a case increases soil salinity. Therefore, researchers took water samples from 10 irrigation ponds in June, July, August and September to evaluate the water quality in irrigation ponds used for irrigation in Hakkari Province. The following parameters were determined in the collected water samples: EC, pH, anions, and cations (Ca⁺², Mg⁺², K⁺, Na⁺, SO₄⁻², NO₃⁻², CO₃⁻², HCO₃⁻ and

Cl⁻). Additionally, using the obtained data, Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC) and Sodium Percentage (% Na) values were also calculated. At the end of the study, it was determined that pH, EC, SAR, RSC and % Na values of the irrigation pond waters did not exceed the limit values, but the Mg⁺² and K⁺ values of the pond water in the Kanatlı area of Akçalı Village and the K⁺ value of the pond water in the Şişer area of Kırıkdağ Village exceeded the limit values.

It was determined in a study on the effect of irrigation water of different qualities on alfalfa that growth slowed down in alfalfa irrigated with saline water and harvest yield and quality decreased. In contrast, when washing was performed and salt was removed from the environment, plant growth returned to normal levels. Accordingly, it was determined that for high alfalfa yields, irrigation water with salinity below 1.5 dSm⁻¹ was appropriate [5].

[6] conducted a study in the Biga Plain of Çanakkale and examined the parameters of electrical conductivity (EC), pH, potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), carbonate (CO₃), bicarbonate (HCO₃), Chloride (Cl), Sulfate (SO₄), Nitrate (NO₃) and Boron (B) in water samples collected from 20 wells. When classified according to the Water Pollution Control Regulation (SKKY) Classification System and considering the salinity parameter, 11 of the 20 wells were classified as second class, while the others were classified as first class.

[7] conducted a study in Isparta Plain and examined the quality of irrigation water samples taken from 21 groundwater wells. It was determined that water quality in some of the wells was classified as C₃S₁ (highly saline-low alkaline), while the water quality in other wells was classified as C₂S₁ (moderately saline-low alkaline).

[8] conducted a study to determine the impact of domestic and industrial wastes on the Nilüfer River. Wastewater samples were taken from the discharge points of five treatment plants discharging into the Nilüfer River and from the streams into which these plants discharge during four different periods between August 2013 and May 2014. It was determined that the wastewater quality parameters of the Nilüfer River and some of the wastewater treatment plants discharging into the Nilüfer River varied depending on the period. When the water parameters were examined before and after discharge from the Nilüfer River, it was determined that the wastewater discharged from the treatment plants had a negative impact on the Nilüfer River, particularly in terms of pH, EC, ammonium, phosphorus, sulfate, boron and chlorine values.

[9] conducted a study in the Sultanhisar district of Aydın Province and indicated that quality of water used for irrigation varied between C₂S₁ and C₃S₁ classes over time, canal water used affected fruit quality and boron content of these waters was higher than that of the control group.

[10] collected irrigation water samples from 12 greenhouse operations of Kırşehir province to determine the quality of irrigation water used in greenhouse operations. Soil samples were also collected from depths of 0–30 and 30–60 cm at the beginning and end of the production period. The pH values of irrigation water samples ranged from 5.47 to 8.61, while electrical conductivity (EC) values varied between 35 - 1720 dS m⁻¹. While calcium, magnesium and potassium concentrations of irrigation water did not pose any problems, 75% of the greenhouse operations had irrigation water with high sodium levels. Considering the crops grown, the soil reactions were found to be suitable for vegetable cultivation, but when EC values were examined, some greenhouse soils showed mild to moderate salinity. It was deemed important for greenhouse operations to regularly analyze irrigation water and monitor soil salinity levels for cultivation purposes.

[11] selected a total of 17 sampling sites along the Awash River and conducted sampling four times a year in different seasons to assess the water quality of the Awash River and its tributaries. Researchers explained the overall water quality and suitability for irrigation using numerous water quality parameters such as EC, pH, RSC, SAR, Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺, CO₃²⁻, HCO₃⁻ and Cl⁻. It was indicated that all quality parameters in Lake Beseka exceeded the maximum permissible limits for irrigation, the physicochemical characteristics of the Awash River varied in different water quality parameters in different areas, only the pH and SAR of Beseka Lake and Meteka spring water exceeded the permitted limit and the EC values in Beseka, Mojo, Wonji, Melkasedi, Ambash, Werer, Meteka and Meteka springs showed medium-high salinity values, while the RSC was very high.

II. MATERIAL AND METHOD

Water samples were taken from 20 irrigation wells in some agricultural fields of Hatunsaray neighborhood of Meram district, Konya province in June, July, August, September and October. Soil samples were also taken from some agricultural fields irrigated by these wells.

Konya Province is located in the south of the Central Anatolia Region. Most of its land is high plains, while the southern and southwestern parts of Konya Province are in the Mediterranean Region. Geographically, Konya is located between 36°41' and 39°16' north latitudes and 31°14' and 34°26' east longitudes (Figure 1) [12]. Its total area is 38,257 km² (excluding lakes). It is the largest province of Türkiye. The average altitude is 1,016 m [13].



FIGURE 1: Map of Konya province (Anonymous, 2022)

Meram district, located 4 km from the center of Konya province, is located between 37°70' north latitudes and 32°30' east longitudes. Its altitude is 1,016 meters. The district is bordered with Beyşehir district to the west, Selçuklu district to the north, Karatay district to the east and Akören district to the south. The district has a total area of 1,680.2 km². The district is generally mountainous, with a flat area in the southeast. The region is mostly covered with steppe vegetation, with some forested areas.

The district has 168,021 ha of arable land. Meram district, which constitutes 4.2% of the arable lands of Konya province and 12.14% of the arable lands of the Lakes Basin, consists of 36.94% agricultural lands, 24.34% forest areas and 10.12% meadow-pasture areas. The forest areas in the district are larger than those in Konya Province [14].

At the high altitudes of Konya Province, where the terrestrial climate prevails, winters are cold and rainy, while summers are hot during the day and cool at night. The temperature difference between night and day is high and rainfall is quite low [2].

Convective rainfall occurs in spring and most precipitation falls during this season. The region's annual average precipitation is 329 mm. Due to the varying topography of Konya Province, average annual precipitation amounts also differ [15].

While the monthly average temperature values in the region range from -0.2°C to 23.5°C, a regular increase in temperature has been observed when long-term temperature changes are examined. Evaporation values reach their highest levels in the summer months. The evaporation value in July is 280 mm, with an annual total of 952 mm [12].

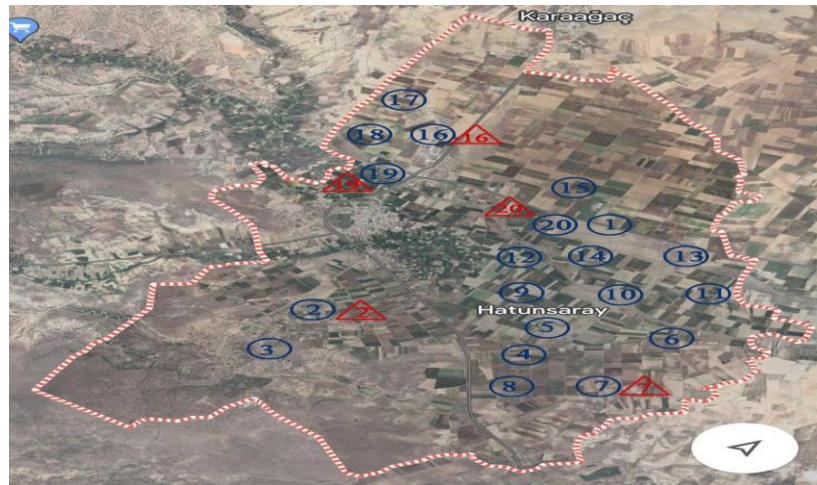
There is a total of 4,083,800 ha of agricultural land in Konya province. Including fallow land, the amount of arable land is 1,876,344 ha [16]. There are 620,638 decares of cultivated land in Meram. Of the land in the district, 57.60% is arable land, 26.61% is fallow land, 7% is vegetable land and 1.17% is fruit and vineyard land. The arable land in the district is less than the proportion of arable land in Konya Province, while the fallow land is more than the fallow land in the province.

The vegetable field ratio in Meram is significantly higher than that of Konya. The ornamental plant ratio is approximately 10 times higher [14].

The total agricultural land in the research area of Hatunsaray is 20,884 decares. Of these lands, 12,568 decares are used for irrigated agriculture, while 8,316 decares are used for dry farming [13].

In Hatunsaray, irrigation water is supplied from underground water wells and the Hatunsaray Reservoir. In the study, water samples were taken from 20 operational wells used for irrigation of agricultural lands. Water quality monitoring was conducted by taking water samples five times between June and October.

From three of the agricultural fields irrigated using the identified wells in the study area (fields numbered 16, 19, and 20), undisturbed and disturbed soil samples were collected at depths of 30 cm up to 90 cm in August and subjected to physical and chemical analyses in a laboratory setting. Soil samples were also collected from fields numbered 2 and 7 and subjected to chemical analysis along with the others. The locations where soil and water samples were collected are shown in Figure 2.



* O irrigation water wells ** Δ soil sampling sites

FIGURE 2. Soil and water sampling sites

III. RESULTS AND DISCUSSION

In this study, samples were taken five times from irrigation wells used to irrigate agricultural lands, once a month in June, July, August, September, and October. The samples were numbered and their pH and EC values are shown in Table 1.

In June, pH values of irrigation water ranged from 6.91 to 7.98 and EC values ranged from 243 to 639 $\mu\text{mhos/cm}$; in July, pH values varied between 7.28 - 7.83 and EC values between 198 - 655 $\mu\text{mhos/cm}$; in August, pH values ranged from 6.91 to 7.87 and EC values ranged from 218 to 730 $\mu\text{mhos/cm}$; in September, pH values varied between 7.12 - 8.22 and EC values between 268 - 760 $\mu\text{mhos/cm}$; and in October, pH values varied between 7.23 - 8.38 and EC values between 201 - 772 $\mu\text{mhos/cm}$ (Table 1).

The EC values of irrigation water samples taken from the region, categorized by month and sample number, are presented in Figures 3, 4, 5, 6 and 7.

The chemical analysis results of irrigation water samples taken from the research area in August are given in Table 2. The pH values of the waters were between 6.91 and 7.87, the EC values were between 218 and 730 $\mu\text{mhos/cm}$ and the boron concentrations were between 0.289 and 0.417 ppm. It was observed that Ca was the dominant cation and HCO_3 was the dominant anion in the water. Sodium Adsorption Ratios (SAR) were found to be between 0.32 and 1.79 and % Na values were between 11.0 and 30.6. The highest amount of residual sodium carbonate (RSC) was determined to be 1.59 (if the RSC value exceeds 2.5, irrigation water is not suitable for agricultural irrigation and may cause adverse effects on the soil). The irrigation water class of the water samples taken from the research area in August is C_2S_1 according to the US Salinity Laboratory [17].

The salinity values of all irrigation samples taken from the wells were found to be below the safe upper limit (750 $\mu\text{mhos/cm}$) (except for 1-2 samples). It was also observed that the water obtained from these wells can easily be used in agricultural production.

The boron concentrations of the irrigation water samples are given in Table 2 and values are also presented in Figure 8. According to the August water analyses, it was determined that the boron concentrations of the irrigation water were below the safe limit (0.7 ppm) and did not pose any problems.

TABLE 1
THE pH AND EC VALUES OF IRRIGATION WATER SAMPLES

Sample No	June-2023		July-2023		August-2023		September-2023		October-2023	
	pH	EC x 10 ⁶ μmhos/cm 25°C	pH	EC x 10 ⁶ μmhos/cm 25°C	pH	EC x 10 ⁶ μmhos/cm 25°C	pH	EC x 10 ⁶ μmhos/cm 25°C	pH	EC x 10 ⁶ μmhos/cm 25°C
1	7,98	441	7,41	449	6,91	423	7,56	383	8,11	305
2	7,83	243	7,60	385	7,57	404	7,79	392	7,82	281
3	7,96	287	7,64	306	7,31	303	8,20	282	8,38	261
4	7,87	359	7,47	355	7,44	374	8,22	271	8,12	330
5	7,69	362	7,64	357	7,46	372	8,14	279	7,72	343
6	7,58	385	7,45	387	7,29	424	7,39	373	7,23	366
7	7,83	370	7,69	385	7,51	416	7,67	363	7,94	359
8	7,74	273	7,65	198	7,60	218	7,55	268	7,82	201
9	7,47	516	7,79	476	7,32	460	7,77	433	8,17	481
10	6,91	584	7,47	557	7,87	557	7,86	565	8,09	507
11	7,75	480	7,56	487	7,39	482	7,60	483	7,58	483
12	7,76	379	7,68	378	7,68	405	7,29	438	7,60	432
13	7,94	327	7,83	317	7,84	295	7,71	303	7,82	310
14	7,81	372	7,66	373	7,78	362	7,75	353	7,75	365
15	7,52	639	7,51	621	7,63	654	7,42	588	7,75	628
16	7,57	459	7,56	456	7,44	447	7,29	438	7,30	442
17	7,69	529	7,42	530	7,39	541	7,12	516	7,64	507
18	7,73	424	7,28	363	7,69	425	7,28	491	7,67	452
19	7,57	631	7,42	636	7,40	730	7,30	760	7,53	772
20	7,69	615	7,46	655	7,52	652	7,30	629	7,35	593

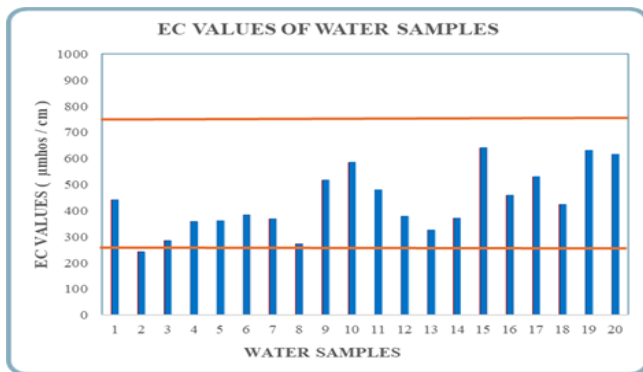


FIGURE 3. EC values of irrigation water in June

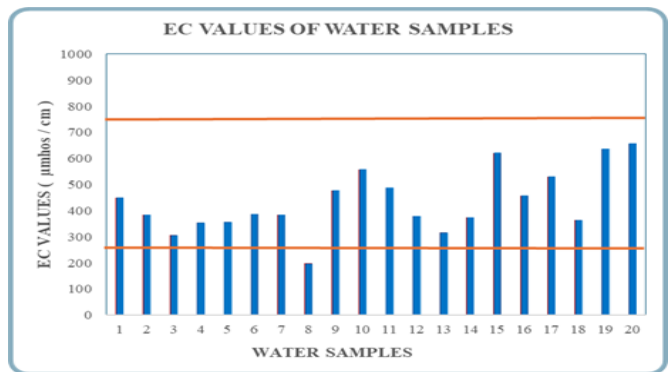


FIGURE 4. EC values of irrigation water in July

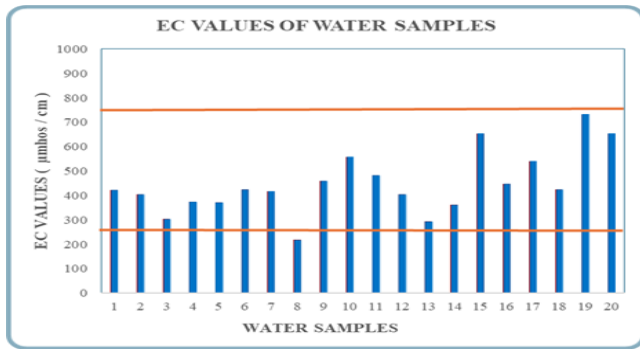


FIGURE 5 EC values of irrigation water in August

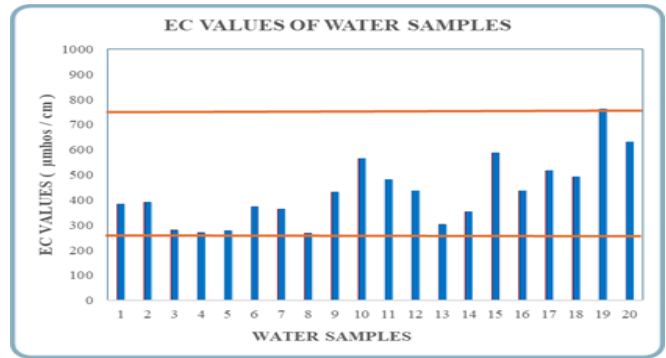


FIGURE 6. EC values of irrigation water in September

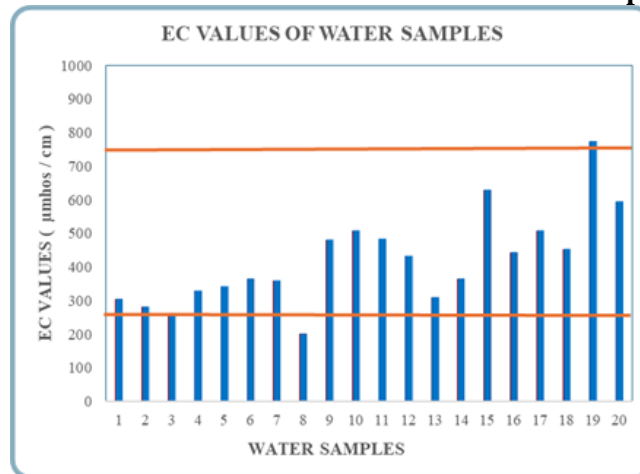


FIGURE 7. EC values of irrigation water in October

TABLE 2
CHEMICAL ANALYSIS RESULTS FOR WATER SAMPLES TAKEN IN AUGUST (2023)

No.	pH	ECx10 ⁶ µmhos/cm 25°C	Water-Soluble											RSC	SAR	%Na	Irrigation Water Class	Boron (ppm)
			Cations (me/l)					Anions (me/l)										
			Na ⁺	K ⁺	Ca ⁺²	Mg ⁺²	Top.	CO ₃ ⁻²	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻²	Top.						
1	6,91	423	0,88	0,18	3,11	0,76	4,9	-	4,1	0,5	0,5	5,1	0,23	0,63	17,8	C ₂ S ₁	0,413	
2	7,57	404	0,84	0,18	3,07	0,6	4,7	-	4,9	0,5	0,3	5,7	1,23	0,62	17,9	C ₂ S ₁	0,315	
3	7,31	303	0,46	0,11	2,64	0,58	3,8	-	4,1	0,3	0,5	4,9	0,88	0,36	16,5	C ₂ S ₁	0,294	
4	7,44	374	0,71	0,11	2,22	0,49	4,5	-	4,2	0,3	0,7	5,2	1,49	0,61	20,1	C ₂ S ₁	0,311	
5	7,46	372	0,73	0,14	2,83	0,52	4,22	-	4,1	0,4	0,8	5,3	0,75	0,56	19,1	C ₂ S ₁	0,291	
6	7,29	424	1,18	0,25	2,96	0,54	4,93	-	4,7	0,5	0,6	5,8	1,2	0,89	27,3	C ₂ S ₁	0,385	
7	7,51	416	1,01	0,12	3,07	0,74	4,9	-	4,9	0,3	0,4	5,6	1,09	0,73	20,4	C ₂ S ₁	0,319	
8	7,60	218	0,36	0,08	2,03	0,43	2,9	-	2,1	0,2	0,8	3,1	-	0,32	16,5	C ₂ S ₁	0,303	
9	7,32	460	0,74	0,14	3,45	0,83	5,16	-	4,2	0,5	0,9	5,6	-	0,51	15,9	C ₂ S ₁	0,327	
10	7,87	557	0,77	0,16	3,67	0,99	5,6	-	4,8	0,8	0,6	6,2	0,14	0,50	13,8	C ₂ S ₁	0,289	
11	7,39	482	1,06	0,17	3,14	1,1	5,5	-	5,1	0,6	0,7	6,4	0,86	0,73	16,4	C ₂ S ₁	0,306	
12	7,68	405	0,72	0,17	2,81	0,99	4,7	-	4,5	0,5	0,8	5,8	0,7	0,52	12,7	C ₂ S ₁	0,302	
13	7,84	295	1,07	0,07	1,91	0,39	3,6	-	3,4	0,5	0,8	4,7	1,1	1,00	31,1	C ₂ S ₁	0,351	
14	7,78	362	0,97	0,07	2,54	0,58	4,2	-	3,9	0,7	0,6	5,2	0,78	0,78	23,3	C ₂ S ₁	0,392	
15	7,63	654	1,1	0,26	3,85	1,7	6,9	-	5,9	0,9	0,7	7,3	0,35	0,66	13,9	C ₂ S ₁	0,34	
16	7,44	447	1,07	0,06	2,96	0,82	4,9	-	4,6	0,8	0,5	5,9	0,82	0,78	22,7	C ₂ S ₁	0,407	
17	7,39	541	0,63	0,06	4,36	0,86	5,9	-	5,6	0,6	0,5	6,7	0,38	0,39	11,0	C ₂ S ₁	0,363	
18	7,69	425	0,9	0,16	2,63	0,89	4,6	-	4,8	0,5	0,6	5,9	1,28	0,68	17,7	C ₂ S ₁	0,331	
19	7,40	730	2,84	0,43	3,24	1,77	8,1	-	6,6	1,3	1,2	9,1	1,59	1,79	30,6	C ₂ S ₁	0,417	
20	7,52	652	1,29	0,26	3,66	1,56	6,8	-	5,9	1,0	0,7	7,6	0,68	0,80	17,0	C ₂ S ₁	0,350	

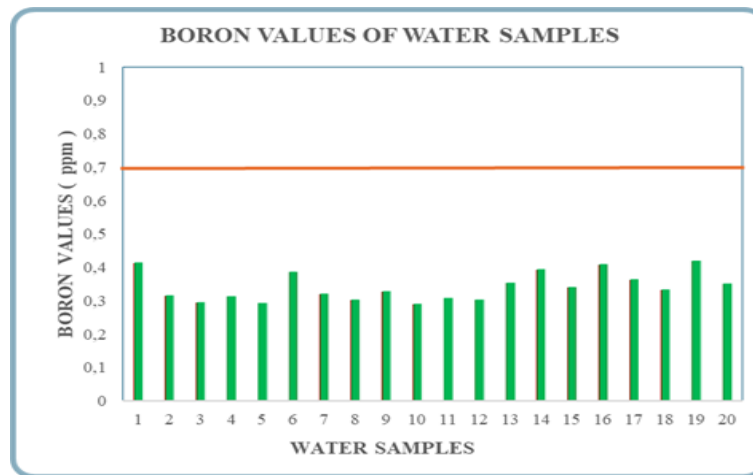


FIGURE 8: Boron concentrations of water samples in August

In the research area, disturbed and undisturbed soil samples were taken from depths of 0-30 cm, 30-60 cm and 60-90 cm in three areas irrigated with irrigation wells. The physical analysis of the soil samples was performed and results are presented in Table 3. Physical analysis results revealed that the saturation percentage values varied between 45 - 55%, the field capacity (FC) values between 29.15 - 32.80%, the wilting point (WP) values between 17.05 - 23.05% and the bulk density values between 1.14 - 1.47 g/cm³. The soil textures were found to be clay-loam, clay, loam and sandy-clay-loam.

**TABLE 3
PHYSICAL PROPERTIES OF THE SOILS TAKEN FROM THE RESEARCH AREA**

Soil sampling site		Saturation (%)	Field Capacity (Volume %)	Wilting Point (Volume %)	Available water	Bulk Density (g/cm ³)	Soil Texture			
Well-Plot no	Depth (cm)						Sand %	Clay %	Silt %	Texture
16	0-30	46	30,25	20,95	9,50	1,26	40,78	35,79	23,43	Clay Loam
	30-60	45	31,10	22,09	9,01	1,36	38,15	40,66	21,19	Clay
	60-90	47	32,20	23,05	9,15	1,47	32,57	41,98	25,48	Clay
19	0-30	48	29,15	17,05	12,10	1,14	49,55	21,14	29,31	Loamy
	30-60	47	29,70	19,60	10,10	1,20	51,09	21,36	27,55	Sand Clay Loam
	60-90	55	32,05	19	13,05	1,20	49,61	21,36	29,33	Loamy
20	0-30	51	31,03	19,53	11,50	1,43	40,78	30,35	28,87	Clay Loam
	30-60	52	31,20	20,15	11,05	1,14	36,0	32,75	31,25	Clay Loam
	60-90	52	32,80	19,65	13,15	1,26	42,35	28,29	28,86	Loamy

Chemical analyses were also performed on soil samples taken from the lands irrigated with five separate wells in the research area and the results are provided in Table 4. The pH values of the soils were measured as between 7.94 - 9.10, while the EC values were measured as between 242 - 857 μ mhos/cm. Based on the salinity threshold value (4000 μ mhos/cm) for all soil layers, it was determined that there was no salinity problem in the soils. The cation exchange capacity (CEC) values of the soil samples ranged from 15.02 to 25.17 me/100 g, while the exchangeable sodium percentages (ESP) ranged from 1.74 to 3.36. It was determined that the ESP was below the threshold value of 15%. The calcium carbonate content of the soil samples ranged from 1.74 to 33.59 and the boron concentrations ranged from 0.17 to 0.26 ppm. It was observed that the boron concentrations were below the threshold value of 4 ppm.

Based on analysis results of the research site provided in Table 4, the EC-Depth relationships are presented in Figure 9.

TABLE 4
CHEMICAL PROPERTIES OF THE SOILS TAKEN FROM THE RESEARCH AREA

Soil Sampling Site		pH	EC x 10 ⁶ µmhos/cm 25°C	WATER-SOLUBLE										CEC (me/100gr)	Exchangeable Sodium	ESP (%)	Lime (%)	Boron (ppm)
Plot No	Depth (cm)			Cations (me/L)					Anions (me/L)									
				Na ⁺	K ⁺	Ca ⁺²	Mg ⁺²	Total	CO ₃ ⁻²	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻²	Total					
2	0-30	8,07	671	1,87	1,03	3,76	0,09	6,66	-	1,5	0,5	4,45	6,45	16,57	0,54	3,25	9,86	0,24
	30-60	8,05	566	1,06	0,48	3,33	0,60	5,47	-	2	0,5	3,17	5,67	19,51	0,45	2,30	7,29	0,22
	60-90	8,00	857	1,02	0,54	5,65	1,01	8,22	-	1	0,5	6,02	7,52	20,80	0,48	2,30	7,15	0,19
7	0-30	7,94	502	0,78	0,19	3,17	0,80	4,94	-	2	-	2,72	4,72	24,88	0,51	2,04	2,57	0,17
	30-60	8,12	310	0,50	1,13	1,12	0,50	3,25	-	1	-	2,65	3,65	23,08	0,52	2,25	1,74	0,18
	60-90	8,02	242	1,26	0,32	1,04	0,42	3,04	-	1	-	2,24	3,24	25,17	0,44	1,74	2,86	0,17
16	0-30	8,12	488	1,37	1,17	2,11	0,86	5,51	-	1,5	-	4,13	5,63	15,17	0,51	3,36	29,16	0,21
	30-60	8,24	444	1,49	0,97	2,08	0,41	4,95	-	2	0,25	2,61	4,86	20,64	0,52	2,51	28,73	0,22
	60-90	8,17	360	1,43	0,74	1,79	0,33	4,29	-	2	0,25	2,44	4,69	19,62	0,38	1,93	33,59	0,26
19	0-30	8,32	621	0,18	1,23	3,79	0,70	5,90	-	1	0,5	4,58	6,08	16,20	0,45	2,77	9,86	0,24
	30-60	8,34	528	0,24	1,00	3,31	0,47	5,02	-	1,5	0,25	3,27	5,02	15,20	0,46	3,02	9,72	0,25
	60-90	8,10	570	0,94	1,29	2,34	0,79	5,36	-	1,5	0,25	3,86	5,61	15,02	0,45	2,99	11,01	0,23
20	0-30	9,10	404	1,07	0,44	2,91	0,16	4,58	-	1,5	0,5	2,18	4,18	16,68	0,54	3,23	14,01	0,21
	30-60	8,37	590	1,04	0,43	3,97	0,13	5,57	-	1	0,25	4,22	5,47	16,49	0,55	3,33	14,44	0,21
	60-90	8,10	413	0,57	0,31	3,12	0,10	4,1	-	3	-	1,32	4,32	15,60	0,50	3,20	13,72	0,21

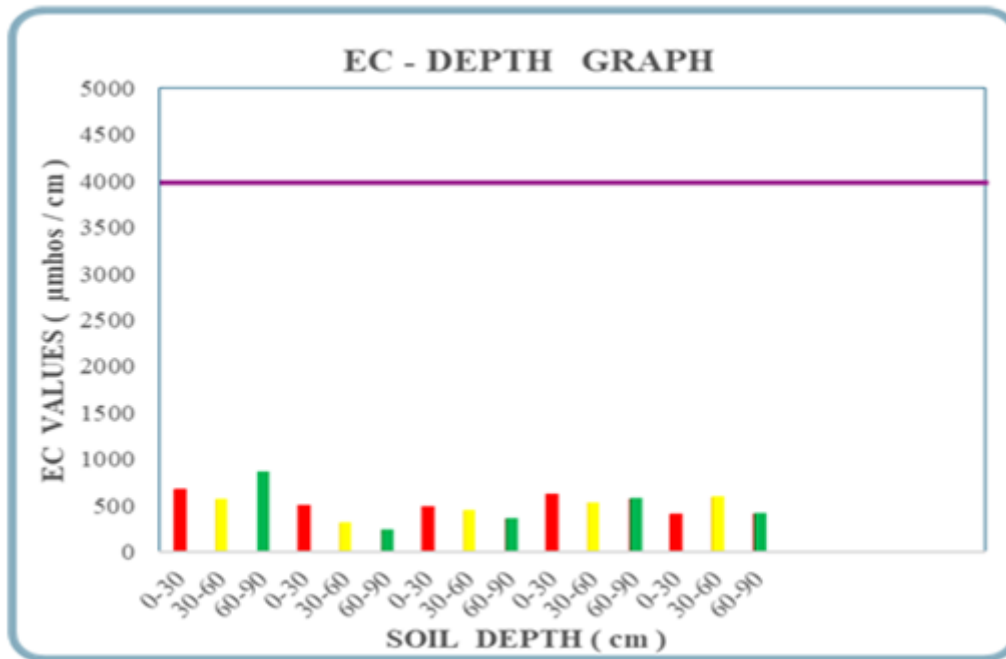


FIGURE 9: Soil EC-Depth relationships

It was observed when the EC values of soil samples taken at different depths were examined that the EC values at depths of 0-30, 30-60 and 60-90 cm were generally between 242 and 857 $\mu\text{mhos/cm}$ (Figure 9). It was found that the EC values of the analyzed agricultural lands and irrigation waters were not high enough to cause salinity. The absence of salt accumulation in the soil is also an indication of salt leaching.

Considering the salt levels in the soil and water in the research area, it can be said that all kinds of agricultural production can be carried out. Measurements taken in the area showed that the boron concentration was less than 4 ppm, which indicates that there is no boron toxicity. All kinds of plants that are sensitive to boron can be grown in the area.

Based on the results of the analyses conducted in the research area, soil ESP-Depth relationships are presented in Figure 10. It was observed that ESP values did not vary with the depth. It was determined that the soil ESP values were below the threshold value of 15%.

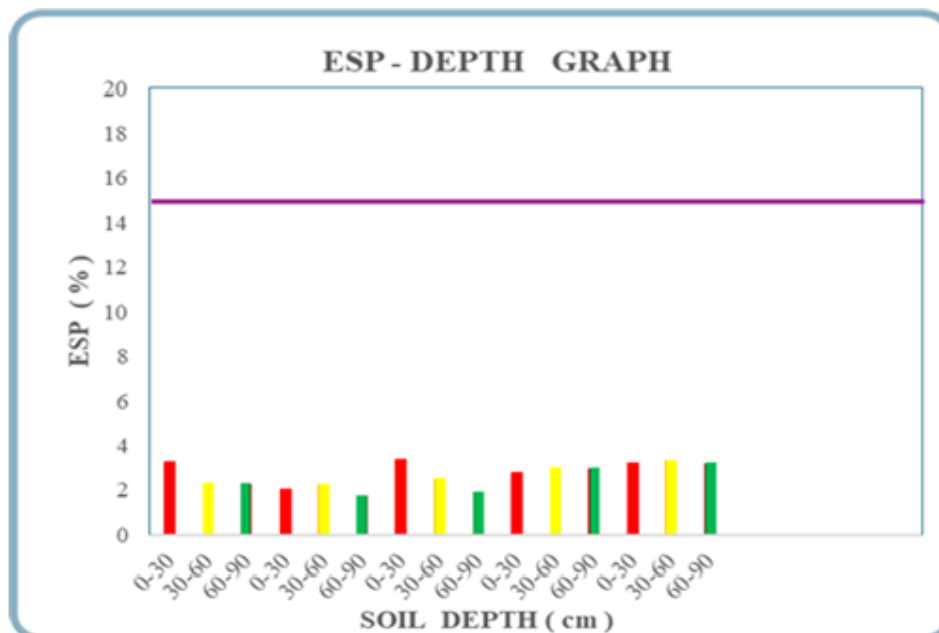


FIGURE 10: Soil ESP-Depth relationship

IV. CONCLUSION AND RECOMMENDATIONS

The results obtained from this study, conducted in Hatunsaray Neighborhood of Meram District of Konya Province to determine the salinity and alkalinity of irrigation water used in agriculture and agricultural lands are summarized below.

4.1 Conclusion:

- 1) The EC values of water samples taken from irrigation wells were below 750 $\mu\text{mhos/cm}$. Due to the medium salinity of the water (C_2), it can be said that the water samples were suitable for agricultural irrigation in terms of salinity. In agricultural fields irrigated with irrigation water samples (C_3) that exceed a threshold salinity value, salt-tolerant plants should be preferred and special measures may be required to control salinity. It was observed that EC values ranged from 198 to 772 $\mu\text{mhos/cm}$, while pH values ranged from 6.91 to 8.38. Based on present analyses, irrigation water was classified as C_2S_1 (moderately saline - low alkaline).
- 2) For water-soluble anions and cations, it can be said that water samples were rich in Ca cation and HCO_3 anion. Sodium adsorption ratios (SAR) ranged from 0.32 to 1.79. Na% values ranged from 11.0 to 31.1 and boron concentrations ranged from 0.289 to 0.417 ppm. It was determined that irrigation water samples were all below the threshold boron concentration 0.7 ppm. The boron values of the irrigation water were also reflected in the soil samples and no boron toxicity was observed in the soils.
- 3) In the research area, the salinity levels of irrigation water were found to be moderately saline. Water samples taken from some irrigation wells in September and October exceeded salinity threshold value of 750 $\mu\text{mhos/cm}$, which could cause salinity problems in agricultural lands where this water is used.
- 4) In this study, chemical analyses of the soils were performed. The pH values of the soils ranged from 7.94 to 9.10 and the EC values ranged from 242 to 857 $\mu\text{mhos/cm}$. The cation exchange capacity (CEC) was found to be between 15.02–25.17 me/100 g, the exchangeable sodium percentage (ESP) values varied between 1.74–3.36%, the lime percentages varied between 1.74 – 33.59% and the boron concentrations ranged from 0.17 to 0.26 ppm. Soil boron concentrations were below the threshold boron concentration of 4 ppm.
- 5) Physical analyses of the soils were also conducted. It was determined that most of the soils were loamy (L) and clay-loam (CL) in texture, with soil saturation percentages of between 45 - 55 and bulk densities of between 1.14 - 1.47 g/cm^3 .
- 6) Soil ESP values were below the threshold value of 15%.

4.2 Recommendations:

- 1) Drainage systems should be installed to prevent salinity problems in agricultural areas. Maintenance and repairs of existing drainage channels must be carried out periodically.
- 2) Soils should be cultivated using appropriate techniques and enriched with organic matter.
- 3) It is likely that salinity and alkalinity problems will arise in the coming years because of climate change-induced decrease in precipitations and the increased need for irrigation water. Therefore, it is important to prioritize leaching and reclamation efforts from now on.
- 4) To prevent yield losses in agricultural production, the irrigation water required by the crop must be provided using appropriate methods. Considering the limited water availability, sprinkler and drip irrigation methods should be preferred in the region. The number of irrigations and the amount of water applied should be planned to avoid unnecessary and excessive irrigation.
- 5) Considering that irrigation water is decreasing day by day, relevant institutions and educational institutions have important tasks in training farmers about irrigation methods and providing them with information on irrigation water applications and ways to increase irrigation efficiency.
- 6) A detailed soil survey should be conducted within the scope of Konya Province and inventory reports should be prepared. The inventory reports, which are quite old, should be updated.

- 7) The absence of salinity, alkalinity and boron problems in both irrigation water and soil samples in the research area does not mean that these problems will not occur in the future. Therefore, even if reclamation studies are not carried out at an advanced level, leaching and soil physical property improvement studies should be carried out.
- 8) Although there are no current issues in the research area, ensuring the supply of high-quality irrigation water to fields in nearby regions where salinity, alkalinity and boron problems are present or may arise is of great importance. Therefore, further development of projects such as the KOP project would be beneficial.

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