Quality Assessment of Irrigation Waters used in Agricultural Fields of Mersin Mezitli District and Irrigation-Induced Soil Salinity Assessments

Onur AVCI[1]; Ahmet Melih YILMAZ[2]*

Department of Farm Building and Irrigation, Faculty of Agriculture, University of Selçuk, Konya-Turkey

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*Corresponding Author

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Abstract— *This study was conducted to determine the irrigation water quality of water sources used in agricultural fields of the Mezitli district of Mersin province and the salinity level of agricultural lands irrigated with these waters. Water samples were taken from water resources used to irrigate lands of the research area once a month for four months (July, August, September and October) during the irrigation season. The pH values of irrigation water samples taken in July, August, September and October varied between 7.05 - 8.26 and the EC values varied between 292 - 1103 µmhos/cm. According to the US Salinity Laboratory Classification System, present water samples were classified as* C_2S_1 *and* C_3S_1*, indicating moderate to high salinity. Boron concentrations of all samples were below the threshold boron level of 0.67 ppm.*

During a period of intensive irrigation in the areas where the research was conducted (August), soil samples were taken from a depth of 30 cm to 90 cm of five plots. Soil textures were identified as clay, loamy and clay-loam. Soil pH values varied between 7.38 - 7.95 and soil EC values varied between 1985 - 3180 µmhos/cm. It was determined that the soil salinity was below the threshold value of 4000 µmhos/cm. No significant differences in quality or quantity were observed in the water samples throughout the irrigation season (July - October) and the soil samples did not pose any risks in terms of salinity and boron toxicity under the current conditions.

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

I. INTRODUCTION

Irrigation water salinity, measured as electrical conductivity (EC), is the most effective water quality indicator for crop productivity. Crops cannot compete with ions in the soil solution for water in case of high EC levels of irrigation water, then salinity-induced yield losses are encountered. The higher the EC, the less water is available to plants, even though the soil appears to be wet **[1].**

Soil salinity and alkalinity are common processes that characterize arid areas in particular. These processes can be attributed to natural conditions or anthropogenic activities. Natural conditions include climate, lithology, topography and pedology, while human-induced activities are mostly related to agricultural land use and in particular to irrigation. Over time, the extent of saline, alkaline and saline-alkaline agricultural lands has increased, such a case then resulted in accelerated land degradation and desertification, reduced agricultural productivity and ultimately jeopardized environmental health and food safety. Mapping and monitoring saline soils is an important management tool aimed at determining the extent and severity of salinization processes. Recent advances in remote sensing methods have increased the effectiveness of mapping and monitoring processes of saline soils. The knowledge and experience regarding the prevention, reduction and improvement of soil salinity and alkalinity have increased significantly over time **[2].**

[3] indicated that in modern irrigation systems, quality of irrigation water is as important as the amount, timing and method of irrigation. When sufficient and good-quality water is not available, water that is unsuitable for irrigation is commonly used. Such a case then increases soil salinity levels. Therefore, to evaluate the water quality in the ponds used for irrigation in Hakkari province, water samples were taken from 10 irrigation ponds in June, July, August and September. The water samples were analyzed for electrical conductivity (EC), pH, anions and cations (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, SO_4^{2-}, NO_3^{2-}, CO_3^{2-}, HCO_3^{-}, and Cl^{-}). Additionally, using the resultant data, Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC) and Sodium Percentage (% Na) values were calculated. It was observed that the pH, EC, SAR, RSC and % Na values of 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 threshold values.

The SAR value of irrigation water is the primary parameter designating water quality class. Therefore, results obtained from studies conducted with sodium salt without considering the SAR value represent sodium damage rather than salt damage. To determine the level of irrigation water salinity that maize lants can tolerate, germination and pot experiments were conducted with irrigation waters of different salt concentrations by setting the SAR value below 1. Germination experiments revealed that root lengths, seedling dry weights and germination rates decreased with increasing irrigation water salinity levels. Root lengths began to be negatively affected at an irrigation water salinity level of 3 dS m^{-1} ECi, while seedling dry weights and germination rates began to be affected at a level of 5 dS m^{-1} ECi. In pot experiments, plant heights and plant dry weights decreased with increasing irrigation water salinity levels and were negatively affected at salinity level of 8 dS m^{-1} ECi **[4].**

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. Contrarily, when leaching (washing) was performed and salts were removed from the environment, plant growth returned to normal levels. Accordingly, it was determined that for high alfalfa yields, irrigation water salinity should be below 1.5 dSm^{-1} **[5].**

Soil salinity and alkalinity occur in arid and semi-arid regions of the world where irrigated agriculture is practiced. Low rainfall, poor-quality irrigation water and high evaporation rates contribute to salinity and alkalinity issues in such regions. These issues also impair the structural properties of the soil (**[6].**; **[7]**).

[8] conducted a study with the irrigation water resources of Ankara Haymana Soğulca Village irrigation cooperative and stated that the irrigation water samples were C_3 (excessively saline water) and could not be used in areas with limited drainage. Despite the presence of salinity issues in the irrigation water resources of the study area, it was noted that no salinity problems arose in the agricultural lands where these waters were used. It was also emphasized that although no salinity issues were observed in the agricultural lands of the region, it is essential to develop both closed and open drainage systems to prevent future salinity problems in these agricultural lands.

[9] examined the possible effects of using drainage water for irrigation on the water and salt balance of the soils in the Harran Plain. It was determined that open drainage canal water in the plain contained less salt than sub-surface drainage water and that salt content decreased toward the end of the season. In areas with drainage systems, the water table level generally remains at a depth of 140–160 cm during the irrigation season. Under these conditions, the SaltMod computer model predicts that root zone salinity will decrease from 7.0 to 3.0 dSm^{-1} within 3 years and to 1.5 dSm^{-1} within 10 years. Additionally, irrigation with water having an EC of 1.5 dSm^{-1} will cause a decrease in soil salinity, while irrigation with water with EC=2.5-3.0 dS m^{-1} and above will cause an increase in soil salinity.

[10] conducted a study in the Biga Plain of Çanakkale province and analyzed water samples taken from 20 wells for 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) parameters. Considering the Water Pollution Control Regulation (SKKY) Classification System, water samples of 11 wells were classified as second class and the others as first class. The study found that apart from nitrate pollution in groundwater, no significant problems had yet emerged in the study area.

[11] conducted a study in the Isparta Plain to examine the quality of irrigation water in water samples taken from 21 groundwater wells and found that the water quality in some of the wells was classified as C_3S_1 (highly saline - low alkaline), while the water quality in other wells was classified as C_2S_1 (moderately saline - low alkaline).

[12] conducted a study to determine the impact of domestic and industrial waste waters on water quality of Nilüfer River. Water samples were taken from the discharge points of five wastewater treatment plants discharging into the Nilüfer River and from the streams into which these plants discharge during four different periods between August 2013 – May 2014. It was determined that the water quality parameters of Nilüfer River and some of the wastewater treatment plants discharging into the Nilüfer River varied depending on the period. Based on the classification made considering EC and SAR, water samples were classified into the C_2S_1 - C_4S_4 classes. It was also determined that the wastewater discharged from treatment plants had a negative impact on the Nilüfer River, particularly in terms of pH, EC, ammonium, phosphorus, sulfate, boron and chlorine values.

It was found in a study conducted by **[13]** in the Sultanhisar district of Aydın Province that the quality of water used for irrigation varied between C_2S_1 and C_3S_1 classes over time. It was also determined that the canal water used affected fruit quality and boron concentrations were higher than that of the control group plants.

[14] selected a total of 17 sampling sites along the Awash River and its tributaries and conducted sampling four times a year in different seasons to assess the water quality of the Awash River and its tributaries. Researchers assessed the overall water quality and suitability for irrigation using numerous water quality parameters such as pH, EC, SAR, RSC, Na^+, K^+, Ca^{++} , Mg^{++}, CO_3^{2-}, HCO_3^- and Cl^-. It was determined that all quality parameters in Lake Beseka exceeded the maximum permissible limits for irrigation, the physicochemical characteristics of the Awash River showed variations in different water quality parameters across different sites. Only the pH and SAR of Beseka Lake and Meteka hot spring water exceeded the permitted limit and the EC values in Mojo, Wonji, Beseka, Melkasedi, Werer, Ambash, Meteka and Meteka hot springs showed medium-high salinity values, while the RSC was very high. It was recommended that wastewater treatment plants should be constructed for industries to improve water quality.

II. MATERIAL AND METHOD

Mezitli district on the Mediterranean coast is highly rich in natural heritage. It has a surface area of 515.79 km^2. Its average elevation above sea level is between 3 - 5 meters. Three-quarters of Mezitli consists of mountains, plateaus and undulating terrains. The coastal strip between the mountains and the sea narrows as it extends westward. The Taurus Mountains, with their geographical position, act as a barrier against northern winds, contributing to the typical Mediterranean climate prevailing in the region.

Mezitli is among the districts with the highest sunshine duration in Turkiye. About 300 days of the year are sunny. The average daily sunshine duration is 7.4 hours, varying between 8–10 hours during the summer months. The average relative humidity is 72%, remaining relatively consistent throughout the year. The average relative humidity varies between 65–75% depending on the month. The annual average temperature is 18.4 °C. The average temperature in summer is 25–33 °C, the average temperature in winter is 9–15 °C and the average sea water temperature is 20 °C. The sea water temperature, which rises to 28 °C in summer, remains at this temperature for a long time, making it the most important factor in extending the tourism season in the district.

The average annual precipitation is 618.6 mm. The highest precipitation is received in December and the lowest in August. There are no plains in the district, but there are mountains in the north named Gemrik, Garkın, Kalegediği, Gelin Kayası, Eyüp Kayası, Hazmur, Karagedik, Gicik Kayası, Hürükızları Kepez, Manıt, Saladağ, Kuşkayası, Durnaz, Peynir and Koca Ellez. These mountains have an average elevation of 1,400 - 1,800 m. The Kandak, Tece and Mezitli rivers flow through the district center.

The maquis, which is seen between 500 and 600 meters above sea level, is a typical plant community of the Mediterranean region that remains green throughout the year. Laurel, wild olive, caper, myrtle, oleander, thorny wood apple, blackberry and rosehip grow naturally in this belt. Forests begin after the maquis. Oak trees grow at 100–1,000 meters, red pine at 100–1,200 meters, black pine at 1,500 meters and cedar and juniper at 2,000 meters. Above 2,500 meters, shrubs and grasslands are found. These are the living areas of the nomads (Yörük) **[15].**

The location of the research site is presented in Figure 1.

FIGURE 1. Research site

Twenty sampling points were selected from surface irrigation water resources used in irrigated agricultural areas of the Mezitli district. Water samples were taken regularly every month for four months during the irrigation season (July-October). The pH and EC readings were made each month and irrigation water samples taken in August were subjected to water-soluble cations (Ca, Mg, Na, K), anions (CO_3, HCO_3, Cl and SO_4) and boron analyses. Measured values were used to calculate sodium percentage (%Na), sodium absorption ratio (SAR), residual sodium carbonate (RSC) and to identify irrigation water quality class.

During a period of intensive irrigation in the areas where the research was conducted (August), soil samples were taken from a depth of 30 cm to 90 cm of five plots. Soil samples were subjected to physical (saturation, field capacity, permanent wilting point, available water, bulk density, texture) and chemical (pH, EC, cations, anions, cation exchange capacity, exchangeable cations, exchangeable sodium percentage, lime, boron) analyses.

III. RESULTS AND DISCUSSION

Water samples were taken from water resources used to irrigate lands of the research area once a month for four months (July, August, September and October) during the irrigation season.

The pH and EC values of irrigation water samples taken in July, September and October are provided in Table 1. In July, pH values of irrigation water samples varied between 7.07 - 8.11 and EC values between 343 - 1045 µmhos/cm. In September, pH values varied between 7.14 - 8.15 and EC values between 308 - 1103 µmhos/cm. In October, pH values of irrigation water samples varied between 7.05 - 8.02 and EC values between 344 - 1056 µmhos/cm.

In July, the highest salinity values were seen in samples 16 and 17: samples 15, 16, 17 and 20 had salinity levels above the threshold salinity level of 750 µmhos/cm, while the other samples were below the safe limit (750 µmhos/cm), making them more suitable for irrigation purposes. In September, the highest salinity values were seen in samples 14, 15, 16 and 17, which exceeded the threshold value of 750 µmhos/cm, while the other samples were below the safe limit value (750 µmhos/cm), making them more suitable for irrigation purposes. In October, the highest salinity levels were seen in samples 14, 15, 16 and 17 with a salinity value of above the threshold salinity value of 750 µmhos/cm, while the other samples were below the safe limit value (750 µmhos/cm), again making them more suitable for irrigation. The EC values of the irrigation water samples taken from the region, categorized by month (July, September, October) and sample number, are presented in Figures 2, 3 and 4.

The chemical analysis results of irrigation water samples for August are provided in Table 2. The pH values of irrigation water samples varied between 7.16 - 8.26, the EC values between 292 - 1101 µmhos/cm and boron concentrations were below the optimal limit of 0.67 ppm in all samples. In terms of water-soluble anions and cations, it can be stated that Ca was dominant among cations and HCO_3 among anions. Sodium adsorption ratios (SAR) ranged from 0.04 to 3.14, % Na values ranged from

1.51 to 47.99 and residual sodium carbonate (RSC) values ranged from 1.72 to 1.90 (in samples 16 and 17). According to US Salinity Lab Classification System, water samples taken in August were classified as C_2S_1 and C_3S_1.

The EC values of the August irrigation water samples based on sample numbers are shown in Figure 5. The highest salinity values were seen in samples 14, 15, 16 and 17, which were above the threshold salinity value of 750 µmhos/cm, while the salinity values of the other samples were below the safe limit value (750 µmhos/cm), making them more suitable for use in irrigating fields.

In terms of boron concentrations given in Table 2, it was observed that boron concentrations of the irrigation water samples were all below the safe boron value of 0.7 ppm, indicating that there would be no boron-related problems with irrigation in August.

TABLE 1
THE pH AND EC VALUES OF IRRIGATION WATER SAMPLES TAKEN IN JULY, SEPTEMBER AND OCTOBER

Sample No	July		September		October	
	pH	EC x 10^6 µmhos/cm 25ºC	pH	EC x 10^6 µmhos/cm 25ºC	pH	EC x 10^6 µmhos/cm 25ºC
1	8,11	549	7,93	551	7,86	548
2	7,72	553	7,88	547	7,98	556
3	7,60	452	8,11	525	8,02	498
4	7,65	435	8,15	516	8,01	502
5	7,40	452	8,08	519	7,88	503
6	7,09	585	7,20	554	7,15	576
7	7,08	582	7,23	570	7,05	565
8	7,60	351	7,82	311	7,88	346
9	7,56	351	7,90	308	7,75	344
10	7,30	343	7,44	353	7,50	349
11	7,31	349	7,50	351	7,66	359
12	7,90	715	7,48	724	7,60	710
13	7,80	717	7,39	730	7,48	720
14	7,11	724	7,15	1015	7,05	935
15	7,09	752	7,14	1040	7,11	1005
16	7,39	1045	7,56	1103	7,45	1018
17	7,31	1045	7,60	1094	7,55	1056
18	7,31	562	7,30	424	7,85	496
19	7,68	569	7,46	416	7,68	511
20	7,07	752	7,22	624	7,26	703

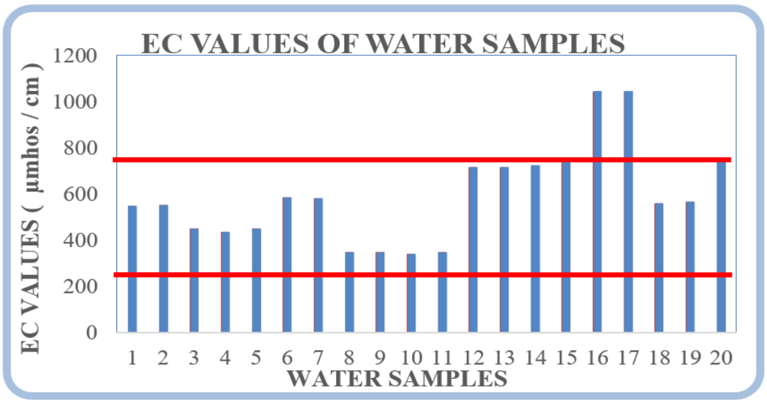

FIGURE 2: EC values of irrigation water samples taken in July

TABLE 2
CHEMICAL ANALYSIS RESULTS OF IRRIGATION WATER SAMPLES TAKEN IN AUGUST

Sample No	pH	ECx10^6 µmos/cm 25 ºC	WATER - SOLUBLE										RSC	SAR	%Na	Irrigation Water Class	Boron (mg/L)
			Cations (me/l)					Anions (me/l)									
			Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Total					
1	7,97	546	0,56	0,04	0,98	3,11	4,69	0,00	1,40	1,74	1,55	4,69	-	0,39	11,97	C_2S_1	<0,67
2	8,04	546	0,56	0,04	0,99	3,21	4,80	0,00	1,40	1,98	1,43	4,81	-	0,39	11,61	C_2S_1	<0,67
3	8,19	534	0,65	0,11	3,36	2,12	6,24	0,00	2,73	1,62	1,88	6,23	-	0,39	10,36	C_2S_1	<0,67
4	8,21	534	0,65	0,11	3,40	2,10	6,26	0,00	3,05	1,74	1,48	6,27	-	0,39	10,43	C_2S_1	<0,67
5	8,26	535	0,65	0,11	3,47	2,12	6,35	0,00	2,90	1,63	1,82	6,35	-	0,39	10,24	C_2S_1	<0,67
6	7,20	560	0,26	0,01	5,53	0,98	6,78	0,00	3,26	1,62	1,90	6,78	-	0,14	3,84	C_2S_1	<0,67
7	7,27	588	0,26	0,01	5,61	1,00	6,88	0,00	3,44	1,53	1,91	6,88	-	0,14	3,75	C_2S_1	<0,67
8	7,85	292	0,06	0,00	3,22	0,29	3,57	0,00	0,45	1,52	1,60	3,57	-	0,04	1,56	C_2S_1	<0,67
9	7,93	293	0,07	0,00	3,20	0,32	3,59	0,00	0,27	1,48	1,85	3,60	-	0,05	1,94	C_2S_1	<0,67
10	7,55	346	0,08	0,01	3,66	0,51	4,26	0,00	0,79	1,58	1,88	4,25	-	0,05	1,81	C_2S_1	<0,67
11	7,49	353	0,07	0,01	3,76	0,49	4,33	0,00	1,08	1,52	1,72	4,32	-	0,05	1,51	C_2S_1	<0,67
12	7,38	709	0,69	0,07	3,47	4,04	8,27	0,00	4,80	1,67	1,80	8,27	-	0,36	8,36	C_2S_1	<0,67
13	7,37	706	0,69	0,07	3,50	4,16	8,42	0,00	4,87	1,62	1,93	8,42	-	0,35	8,22	C_2S_1	<0,67
14	7,21	1082	1,64	0,05	5,24	5,43	12,36	0,00	8,80	1,84	1,73	12,37	-	0,71	13,30	C_3S_1	<0,67
15	7,16	1101	1,65	0,05	5,13	5,27	12,10	0,00	8,77	1,87	1,46	12,10	-	0,72	13,64	C_3S_1	<0,67
16	7,51	1082	5,12	0,08	1,96	4,12	11,28	0,00	7,80	1,81	1,67	11,28	1,72	2,94	45,39	C_3S_1	<0,67
17	7,55	1097	5,26	0,08	1,47	4,14	10,95	0,00	7,51	1,69	1,75	10,95	1,90	3,14	47,99	C_3S_1	<0,67
18	7,94	362	0,12	0,01	3,30	1,06	4,49	0,00	1,30	1,98	1,21	4,49	-	0,08	2,63	C_2S_1	<0,67
19	7,73	355	0,13	0,01	3,40	1,07	4,61	0,00	1,25	1,67	1,68	4,60	-	0,09	2,78	C_2S_1	<0,67
20	7,30	599	0,47	0,01	4,49	2,22	7,19	0,00	3,73	1,91	1,56	7,20	-	0,26	6,58	C_2S_1	<0,67

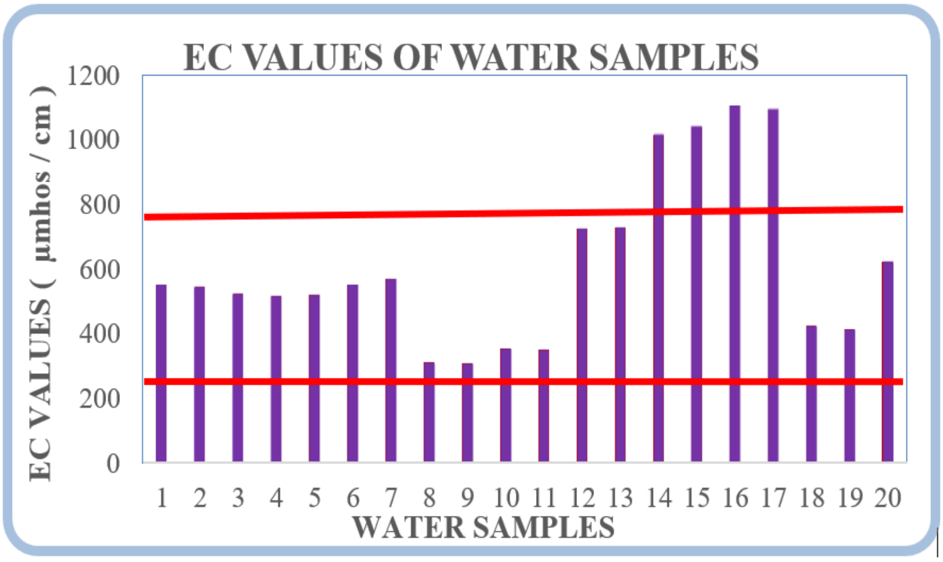

FIGURE 3: EC values of irrigation water samples taken in September

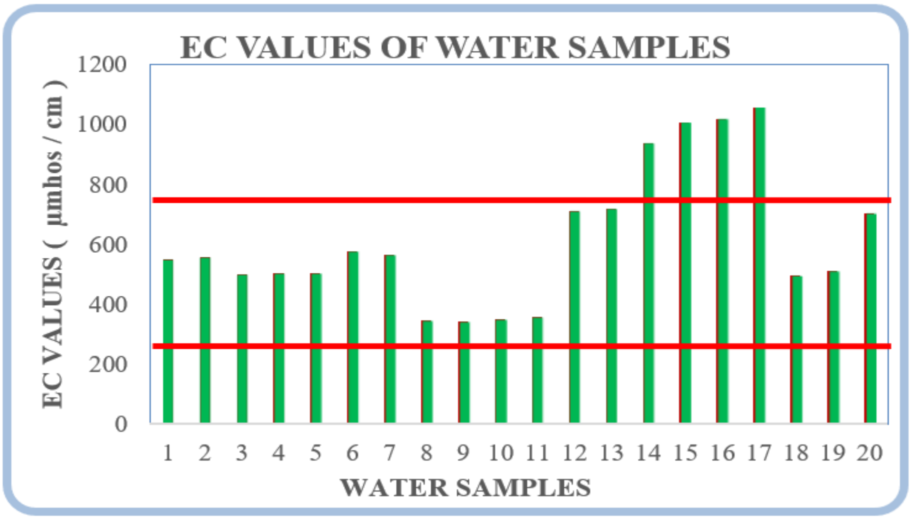

FIGURE 4: EC values of irrigation water samples taken in October

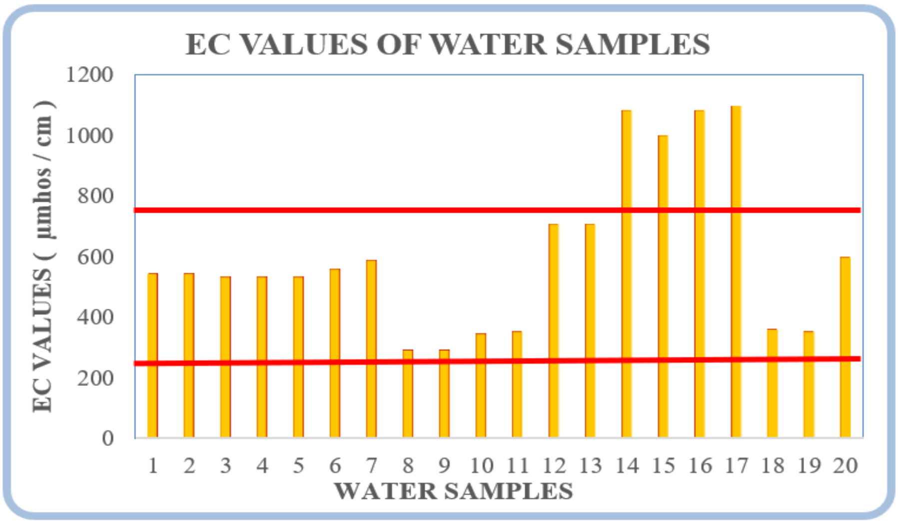

FIGURE 5: EC values of irrigation water samples taken in August

Physical and chemical analysis results of the soil samples taken from the research area are provided in Table 3 and Table 4. Soil textures were identified as loamy (L), clay-loam (CL) and clay (C), with saturation values ranging from 50.45% to

114.35% (which can exceed 100% depending on the clay type), field capacity values of between 22.50 - 36.40%, permanent wilting points of between 13.98 - 24.46% and bulk density values of between 1.28 - 1.39 g/cm³ (Table 3). Soil pH values varied between 7.38 - 7.95 and salinity values varied between 1985 - 3180 µmhos/cm. Soil samples all had salinity levels of below the threshold salinity value of 4000 µmhos/cm (Table 4).

While HCO_3^- was the dominant water-soluble anion, Ca^{+2} was the dominant cation. The boron concentrations of all samples were found to be below 4 ppm, ranging from 0.25 to 0.39 ppm. Cation exchange capacities (CEC) ranged from 8.95 to 13.16 me/100 g, while exchangeable sodium percentages (ESP) ranged from 6.59 to 14.86%, both below the accepted ESP threshold of 15%. The lime values were found to vary between 7.78% and 49.23%.

The relationships between soil EC and depth is shown in Figure 6 and the relationships between soil ESP and depth is shown in Figure 7. The relationships between EC and depth of soil samples showed that the average EC values at depths of 0-30, 30-60, and 60-90 were between 2000 and 3000 µmhos/cm, with no significant differences between the depth segments. The high EC values observed in some irrigation water samples indicate that the soil is not becoming saline, but rather that salt is leached from the soil. Figure 7 shows that there is no change in ESP values with the depth and ESP values were all below the accepted limit value of 15%.

TABLE 3
SOIL PHYSICAL ANALYSIS RESULTS

Soil Sampling		Saturation (%)	Field Capacity (Volume %)	Permanent Wilting Point (Volume %)	Available Water (%)	Bulk Density (g/cm^{-3})	Soil Particles			Soil Texture
Plot No	Depth (cm)						Sand %	Clay %	Silt %	
1	0-30	50,60	22,74	13,98	8,76	1,33	49,01	22,43	28,56	L
	30-60	50,75	22,80	17,70	5,10	1,34	52,10	22,43	25,00	L
	60-90	50,45	22,50	21,35	1,15	1,36	49,00	23,50	20,50	L
2	0-30	93,50	34,96	24,24	10,72	1,28	39,71	44,86	15,42	C
	30-60	93,70	35,23	24,35	10,88	1,32	39,70	40,30	15,80	C
	60-90	93,55	34,75	24,46	10,29	1,38	42,50	40,20	15,40	C
3	0-30	68,20	27,49	18,13	9,36	1,29	37,93	33,01	29,06	CL
	30-60	66,30	27,12	18,54	8,58	1,35	39,80	33,00	25,20	CL
	60-90	66,15	26,96	18,35	8,61	1,39	37,93	28,50	31,30	CL
4	0-30	75,90	34,56	23,81	10,75	1,29	39,79	42,22	18,00	C
	30-60	76,10	34,88	23,96	10,92	1,32	40,56	46,50	14,50	C
	60-90	73,60	33,96	24,18	9,78	1,36	40,60	42,22	16,20	C
5	0-30	112,20	35,92	23,03	12,89	1,28	31,20	45,08	17,35	C
	30-60	111,40	35,76	23,55	12,21	1,30	33,60	42,50	17,50	C
	60-90	114,35	36,40	23,50	12,90	1,33	37,75	42,50	14,30	C

TABLE 4
SOIL CHEMICAL ANALYSIS RESULTS

Soil Sampling		pH	EC x 10^6 µmos/cm 25 ºC	Water - Soluble										CEC (me/100 g)	Exchangeable Cations			ESP (%)	Lime (%)	Boron (ppm)
				Cations (me/l)					Anions (me/l)											
Plot No	Depth (cm)			Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	Total		Na^+	K^+	Ca^{+2}+Mg^{+2}			
1	0-30	7,73	1985	0,63	0,25	19,38	1,71	21,97	-	12,23	3,02	4,51	19,76	8,95	1,33	1,46	6,16	14,86	37,69	0,37
	30-60	7,80	2135	0,62	0,29	19,12	1,70	21,73	-	11,15	3,20	5,70	20,05	9,42	0,76	1,44	7,22	8,07	37,10	0,37
	60-90	7,87	2180	0,59	0,25	18,86	1,65	21,35	-	10,56	4,86	4,35	19,77	11,71	1,29	1,96	8,46	11,02	37,10	0,35
2	0-30	7,73	3047	0,61	2,70	23,11	5,88	32,30	-	18,36	6,30	7,60	32,26	11,98	1,19	2,47	8,32	9,93	25,67	0,37
	30-60	7,95	3180	0,52	2,40	23,22	5,80	31,94	-	18,54	6,20	7,50	32,24	11,70	1,38	2,12	8,20	11,79	25,66	0,35
	60-90	7,86	3177	0,48	2,32	23,10	5,80	31,70	-	16,50	6,98	5,30	28,78	13,16	1,61	2,50	9,05	12,23	25,60	0,35
3	0-30	7,46	2056	0,58	0,57	16,7	3,75	21,60	-	13,67	3,45	4,75	21,87	9,94	0,76	2,22	6,96	7,65	49,23	0,39
	30-60	7,48	2040	0,55	0,55	16,20	3,65	20,95	-	13,20	4,96	2,55	20,71	10,94	1,15	2,10	7,69	10,51	48,56	0,37
	60-90	7,54	1996	0,58	0,50	15,97	3,62	20,67	-	13,02	4,02	3,60	20,64	9,42	0,80	1,86	6,76	8,49	48,65	0,39
4	0-30	7,65	3084	0,50	0,61	26,17	3,75	31,03	-	14,78	5,87	10,23	30,88	10,23	0,81	1,98	7,44	7,92	7,96	0,25
	30-60	7,56	3060	0,50	0,65	26,38	3,70	31,23	-	15,30	6,22	9,48	31,00	10,12	0,76	2,09	7,27	7,51	7,78	0,25
	60-90	7,38	3074	0,48	0,62	25,96	3,50	30,56	-	13,56	6,24	10,25	30,05	9,56	0,63	1,88	7,05	6,59	7,82	0,25
5	0-30	7,90	2727	0,74	1,11	17,27	8,86	27,98	-	13,22	3,67	10,91	27,80	11,14	0,88	2,37	7,89	7,90	35,17	0,27
	30-60	7,93	2696	0,72	1,02	17,23	8,84	27,81	-	13,37	3,54	9,86	26,77	11,19	1,04	2,35	7,80	9,29	34,50	0,27
	60-90	7,86	2695	0,66	0,95	16,84	8,80	27,25	-	10,66	6,58	9,16	26,40	12,20	1,28	2,66	8,26	10,49	34,20	0,25

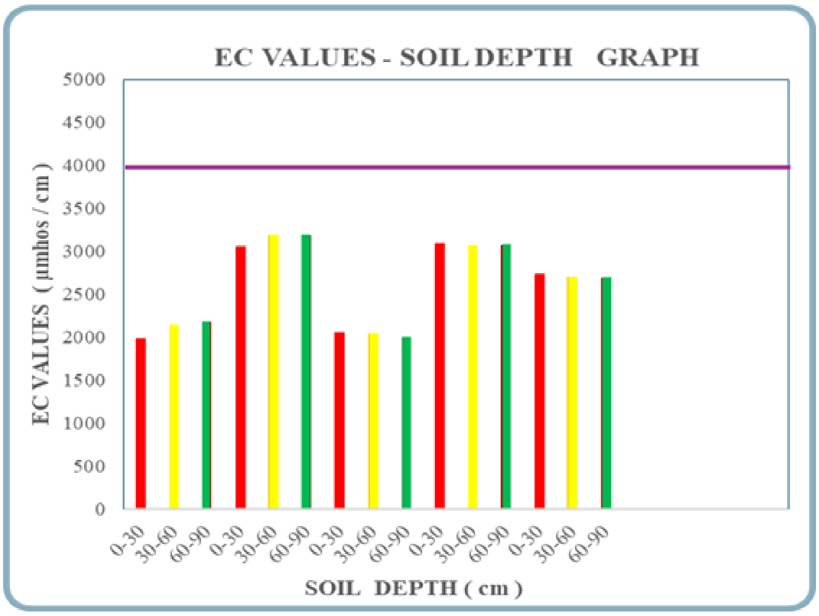

FIGURE 6: Soil EC – Depth relationships

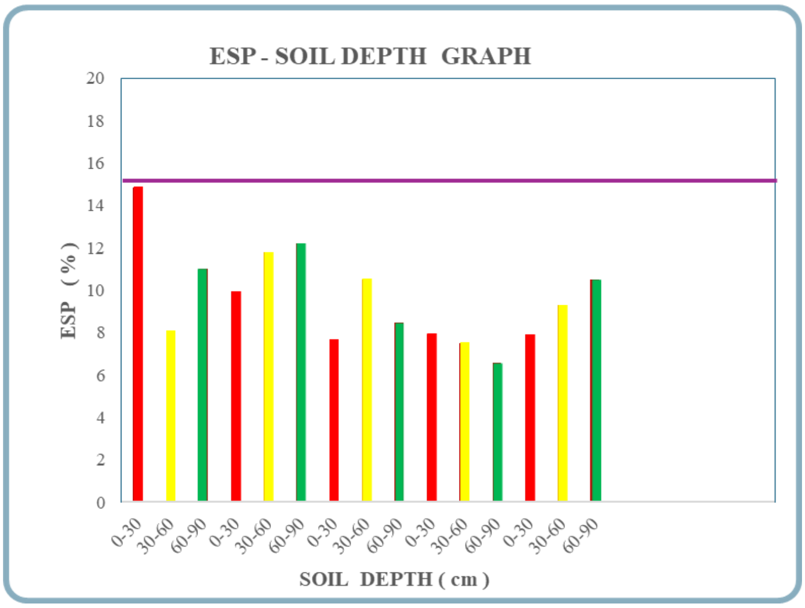

FIGURE 7: Soil ESP – Depth relationships

IV. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions:

The following conclusions were drawn from the present study conducted to assess the quality of water resources used in irrigation of agricultural fields in Mezitli district of Mersin province.

a) Since the irrigation water samples with a salinity level of below the threshold salinity value of 750 µmhos/cm are classified as **moderately saline waters (C_2)**, these waters are considered to be suitable for use in irrigating the land in these regions. On the other hand, irrigation water samples with a salinity level of above the threshold salinity value of 750 µmhos/cm are classified as **highly saline water (C_3)** and necessary measures should be taken and more salt-tolerant plants should be selected for cultivation when these waters were used in irrigations. The EC values of the present irrigation water samples varied between 292 - 1103 µmhos/cm and the pH values varied between 7.05 - 8.26. Based on these values, the irrigation water quality classes have been determined as C_2S_1 (moderately saline - low alkaline) and C_3S_1 (highly saline - low alkaline).

b) In terms of water-soluble anions and cations, Ca^{++} can be said to be the dominant cation and HCO_3^- the dominant anion. The sodium adsorption ratios (SAR) of the samples ranged from 0.04 to 3.14, while the % Na values varied between 1.51 and 47.99 and the boron concentrations of all samples were below the threshold level of 0.7 ppm.

c) Soil EC values varied between 1985 - 3180 µmhos/cm, pH values between 7.38- 7.95, lime percentages between 7.78 - 49.23, ESP values between 6.59 - 14.86, which were below the threshold value of 15%, boron concentrations varied between 0.25 - 0.39 ppm, which were below the threshold boron concentration of 4 ppm and CEC values ranged from 8.95 to 13.16 me/100 g.

d) Soil textures were identified as loamy (L), clay-loam (CL) and clay (C), with saturation percentages of between 50.45 - 114.35%, field capacity values of between 22.50 - 36.40, permanent wilting point values of between 13.98 - 24.46 and bulk density values of between 1.28 - 1.39 g/cm³.

e) Although some of the irrigation water used for agricultural purposes in the study area was classified as highly saline (C_3), the reason why the soil has not yet become saline is that irrigation has not been carried out at a level that would cause salt accumulation, or that the soil has been well leached.

4.2 Recommendations:

a) New drainage facilities should be installed and periodic maintenance should be performed on existing drainage facilities to prevent salinity problems.

b) Soils should be enriched and soil cultivation methods should be selected appropriately to prevent the organic matter content of soils from decreasing over time.

c) Measures should be taken immediately to prevent salinity and alkalinity problems in agricultural lands and attention should be paid to reclamation and leaching activities.

d) Irrigation should be carried out using appropriate irrigation methods to prevent yield losses. Considering irrigation practices, sprinkler irrigation should be preferred in regions with insufficient water resources, while flooding irrigation should be preferred in regions with sufficient water resources.

e) Relevant institutions and organizations should provide training on soil-plant-water relationships and irrigation water quality to raise farmers' awareness on these issues.

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