Asian Journal of Chemistry Vol. 20, No. 1 (2008), 694-704

Determination of Irrigation Water Quality of Lake Beysehir and Other Water Sources Used in Irrigation of Çumra Plain

M. ZENGIN*, S. KARAKAPLAN and ILKNUR ERSOY
Department of Soil Science, Faculty of Agriculture
University of Selcuk, 42031 Konya, Turkey
E-mail: mzengin@selcuk.edu.tr

In this research, irrigation water quality and pollutions of Lakes Beysehir and Sugla, Dams Apa and May used in irrigation of Çumra Plain were determined. Canal Çarsamba which is leading from Lake Beysehir to Çumra Plain and has about 150 km length is connected with Lake Sugla, Dams Apa and May along the route. In the irrigation water samples collected at four different times and from five points pH, EC, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, CO_3^{2-}, HCO_3^{-}, Cl^{-}, SO_4^{2-}, NO_3^{-}, Fe^{2+}, Cu^{2+}, Mn^{2+}, Zn^{2+} and B were also analyzed and from these results SAR, RSC and quality classes were also determined. It was evaluated that all of the water samples had moderate alkaline pH values, class II salty and class I alkalinity (C_2S_1), class I RSC, class I and II B level and from Lake Beysehir to Dam May along the Canal Çarsamba, nitrate and heavy metals increased and boron contents decreased.

Key Words: Lake Beysehir, Irrigation, Pollution, Water quality.

INTRODUCTION

Water is very important matter for both livings and agriculture. Water is plant nutrient and it has a very important role in biological events in plant body, aids to biochemical reactions, solves and carries nutrition and briefly effects growing and changing in plant. That's why it is a fertility factor in agriculture. Quality irrigation water used in agricultural lands must contains plant nutrients at sufficient and appropriate rates and not contains harmful matters for plant and soil and has neutral pH and low salt concentration.

The surface and underground waters of Izmir, Manisa, Aydin and Mugla provinces had slightly acid-alkaline reaction (pH), low and very high salinity (EC), low and very high alkalinity (Na) and low and high boron (B) levels[1]. The irrigation waters of Central Aegean Region were slightly7 acid-alkaline reaction (pH), have low and very high salinity (EC), low and very high alkalinity (Na) and low and high boron (B) levels[2].

It is necessary that complete chemical analyzed for correct evaluation of water quality. An analysis must contain Ca^{2+}, Mg^{2+}, Na^+ and K^+ cations and CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-} and NO_3^- anions analysis[3]. Reliability of the results of irrigation water analysis depends on taking correct water samples[4].

Quality of irrigation water determines whether it will be used or not in agriculture, effect salinity-alkalinity in soil or not, will give toxic elements into soil or not and will be grown crop according to water quality[5,6]. Quality of water must absolutely take into consideration in irrigation. Because, the salt level of irrigation waters depend on resource property. Use appropriateness of waters is connected with salts quantity and species[7,8].

Chemical compositions of irrigation waters are effected by soil and geological properties of the region from where this waters spring and gather. As a result of this, the type and quantities of chemicals contained could be different, that's why irrigation water can either be useful or harmful to plants and sometime large areas of agricultural lands are became desert due to inconvenient practices[9]. Many of the soils are became barren in especially Çumra, Çukurova, Menemen and Igdir like semi arid regions in Turkey because wrong water and irrigation methods[10,11].

Irrigation that is one of the important inputs in agricultural production is realized from like dam and pond or natural rivers. Dam and ponds where stored water and are foundations made for the least consumption use water is being necessary of plants[12].

In this study, water samples collected at four different times (October 2000, January, April and July 2001), from five points (lake Beysehir inside part and outlet, lake Sugla, Dams Apa and May outlets) were analyzed and evaluated with respect to irrigation water quality and pollution.

EXPERIMENTAL

The investigation material covers 20 irrigation water samples collected at four different times and from five different points (Table-1).

TABLE-1
SAMPLING PLACES

Water	Places
Lake	It is in the west and 90 km far from Konya province, the inside part and surface of lake Beysehir
Lake	It is in the west and 90 km far from Konya province, the outlet and surface of Canal Çarsamba of lake Beysehir
Lake	It is in the southeast of Seydisehir district, the outlet and surface of lake Sugla
Dam	It is in the south and 65 km far from Konya province, the outlet and surface of Dam Apa
Dam	It is in the south and 59 km far from Konya province, the outlet and surface of Dam May

Some information on the water sampling places

Lake Beysehir: It is in the west and 90 km far from Konya city, covers the northwest of Beysehir district and surrounded with high mountains from the northwest, west and southwest. Lake is supported by brooks like Deli and Bademli Brooks resulting from these mountains. It is third big lake of Turkey with respect to square measure and first big lake with respect to fresh water resource. It is from tectonic origin and has about 650 square kilometers. Geology of lake taken part in a fault subsidence west has kretase limestone and east side has neojen marl and limestone[13,14]. The deepest of the lake is about 10 m and it has 1121 m of altitude. It is made use of both fresh water of the lake by Canal Çarsamba in irrigation of Plain Çumra and fishing[15]. It is the biggest lake in the vicinity after Lake Salt. Lake environs have marsh and reed bed, especially in the south. Its waters have rich in plankton population and green-grey colour[16]. Its drainage area is 4086 Km^2. It is benefited from lake water as drinking water after chlorine treatment. The lake informed as drinkable water and categorized as oligotrophic is a good potential for fresh water products[17].

Lake Sugla: It is situated in the south of Seydisehir district and south-east and about 40 km far from lake Beysehir. Sometimes it lost their water and then it is cultivated on the dry areas. In addition, in some years water fills in the lake floor, which is sloping towards southeast[18]. Lake Sugla formed in the low part of Seydisehir plain is a tectonic and shallow lake and has 1095 m altitude and 16 500 ha area. It is filled by Akçay and Özler Brooks resulting from south of Seydisehir, Canal Çarsamba coming from Lake Beysehir and the other small brooks. Lake waters are emptied by means of small swallow holes found in the west, an outlet going to Canal Çarsamba in the east. A big part of waters of the lake dries in summer because of irregular filling and shallowness and on these areas it is generally cultivated chickpea[19].

Dam Apa: It is in the south of about 65 km far from Konya province and was built with the aim of irrigation and protection from flood. Dam Apa has 169 million m^3 water/year and irrigates about 18 000 ha agricultural areas. It was built as soil filling type, its kret high is 31.5 m and it has 12.60 km^2 surface areas[16,20].

Dam May: It is in the south of about 59 km far from Konya province and it was built with the aim of irrigation and protection from flood as soil filling type. Dam May stores 42 million m^3 water/year and irrigates 4000 ha agricultural areas. Its kret high is 19.6 m and it has 7.75 km^2 surface areas.

Çumra Plain is in the south of Konya province between 37º 51' north latitude and 32º 47' east longitude. Its altitude is about 1013 m and there, summers are hot and rainless, winters are cold and rainy. The average temperature 10.7 ºC, average relative humidity 63.1 % and average precipitation 301.4 mm per a year. In Çumra plain which has 107114 ha cultivatable area, there are 85000 ha irrigable area and 48000 ha present irrigating area. It has clay soil character and is benefited from surface and underground waters in the irrigation. The source of surface water is Dam Apa. The lakes Beysehir and Sugla and Canal Çarsamba flow constitute the reserve of Dam Apa, too. It is taken that average 335 millions m^3/year irrigation water from Dam Apa. Cereals were commonly cultivated in Çumra plain. The other some important plants such as sugar beet, vegetable, food plants, leguminous and fruit are also grown. Plant design is cereals 75 %, sugar beet 15 %, leguminous 3 %, vegetable 2 % and fruit 2 %[21].

Water samples were collected from inside and flowing parts of sampling place into polyethylene 1 L bottles in autumn (October, 2000), winter (January, 2001) and spring (April, 2001) seasons at dormant seasons and growing seasons (July, 2001) when the irrigation is realized. The clean bottles were entirely filled with and immediately carried to the laboratory in closed bags. In the water specimens kept in the refrigerator, pH (pH meter), EC (EC meter), Ca^{2+}, Mg^{2+} (EDTA volumetric titration), Na^+, K^+ (flame photometer), CO_3^{2-}, HCO_3^-, Cl^- (volumetric titration), SO_4^{2-} (spectrophotometer), NO_3^- (Kjeldahl), Fe, Cu, Mn, Zn (atomic absorption spectrometer) and B (spectrophotometer) were analyzed[22]. From these results RSC, SAR and quality classes were also determined. In determination of RSC and SAR; RSC = $(CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$, SAR = $Na^+[(Ca^{2+} + Mg^{2+})^{-2}]^{-1}$ were used, respectively. The quality classes (C_xS_x) were determined according to the diagram of salinity laboratory of USA[23].

RESULTS AND DISCUSSION

The analysis results of 20 irrigation water samples taken from some surface waters used in the irrigation of Çumra plain were given in Tables 2-5.

Analysis results of October 2000

The analysis results of irrigation water samples collected in October were given in Table-2. The pH values of irrigation water samples were found between 8.00 (Lake Beysehir outlet) and 8.30 (Dam Apa). Average pH value was 8.15. The pH values were ranged around normal (6.50-8.50) limits[26]. The pH value of lake Beysehir water was reported as 7.97 and for Dam Apa 8.40 in October, 1991[24]. As it is seen, the pH values of samples are high because these waters result from calcareous formation. It was determined that the pH values of water of Dam Keban situated in north of research area is quite high, 8.12-8.80[25].

The electrical conductivity (EC) values of samples were ranged from 380 μmhos cm^{-1} being Class II (C_2) for Dam May to 612 μmhos cm^{-1} being Class II (C_2) for Dam Apa. The average EC value was found as 503 μmhos

TABLE-2
CHEMICAL ANALYSIS RESULTS OF THE WATER SAMPLES COLLECTED IN OCTOBER 2000

Samples	pH	EC×10[6] (25 ºC)	Cations (me L^{-1})					Anions (me L^{-1})						Trace Elements (mg L^{-1})					SAR	RSC me L^{-1}	Qu. Cls
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	ΣC	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	ΣA	Fe	Cu	Mn	Zn	B			
LB (ins.)	8.15	530	1.40	3.41	0.46	0.07	5.34	0.20	0.50	2.67	1.98	0.01	5.36	0.00	0	0	0.00	0.86	0.30	0	C_2S_1
LB (out.)	8.00	550	1.40	3.64	0.47	0.06	5.57	0.15	0.72	2.76	1.88	0.01	5.52	0.00	0	0	0.00	0.65	0.30	0	C_2S_1
L. Sugla	8.10	445	0.60	3.25	0.53	0.06	4.44	0.04	0.10	2.30	2.00	0.01	4.45	0.00	0	0	0.01	0.61	0.38	0	C_2S_1
D. Apa	8.30	612	1.40	4.05	0.59	0.06	6.10	0.06	0.15	3.71	2.17	0.02	6.11	0.00	0	0	0.01	0.53	0.36	0	C_2S_1
D. May	8.20	380	1.60	1.41	0.63	0.13	3.77	0.00	0.50	2.00	1.26	0.02	3.78	2.75	0	0	0.03	0.56	0.51	0	C_2S_1
Average	8.15	503	1.28	3.15	0.54	0.07	5.04	0.09	0.39	2.69	1.86	0.01	5.04	0.55	0	0	0.01	0.64	0.37	0	C_2S_1

TABLE-3
CHEMICAL ANALYSIS RESULTS OF THE WATER SAMPLES COLLECTED IN JANUARY 2001

Samples	pH	EC×10[6] (25 ºC)	Cations (me L^{-1})					Anions (me L^{-1})						Trace Elements (mg L^{-1})					SAR	RSC me L^{-1}	Qu. Cls
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	ΣC	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	ΣA	Fe	Cu	Mn	Zn	B			
LB (ins.)	8.21	560	2.40	3.34	0.19	0.04	5.97	0.17	1.22	2.74	1.81	0.01	5.95	0.00	0	0	0	0.45	0.11	0	C_2S_1
LB (out.)	8.28	430	0.60	3.44	0.22	0.02	4.28	0.27	1.34	1.47	1.20	0.01	4.29	0.00	0	0	0	0.09	0.15	0	C_2S_1
L. Sugla	7.50	510	2.80	1.81	0.44	0.04	5.09	0.00	0.47	3.00	1.59	0.02	5.08	0.00	0	0	0	0.05	0.28	0	C_2S_1
D. Apa	8.06	500	1.20	3.44	0.28	0.02	4.94	0.10	1.24	1.57	2.10	0.01	5.02	0.00	0	0	0	0.00	0.18	0	C_2S_1
D. May	8.24	635	6.01	0	0.25	0.08	6.34	0.00	1.23	1.74	3.36	0.01	6.34	3.02	0	0	0	0.00	0.14	0	C_2S_1
Average	8.06	527	2.60	2.40	0.27	0.04	5.31	0.11	1.10	2.10	2.01	0.01	5.33	0.60	0	0	0	0.12	0.17	0	C_2S_1

TABLE-4
CHEMICAL ANALYSIS RESULTS OF THE WATER SAMPLES COLLECTED IN APRIL 2001

Samples	pH	EC×10^6 (25 ºC)	Cations (me L^{-1})					Anions (me L^{-1})						Trace Elements (mg L^{-1})					SAR	RSC me L^{-1}	Qu. Cls
			Ca^{2+}	Mg^{2+}	Na^+	K^+	ΣC	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	ΣA	Fe	Cu	Mn	Zn	B			
LB (ins.)	8.35	460	4.00	0.40	0.17	0.02	4.59	0.00	1.59	0.49	2.50	0.01	4.59	0.00	0	0	0	0.27	0.11	0	C_2S_1
LB (out.)	8.40	325	1.63	1.42	0.16	0.02	3.23	0.16	1.21	0.22	1.66	0.01	3.26	0.00	0	0	0	0.21	0.13	0	C_2S_1
L. Sugla	7.99	555	1.00	3.64	0.29	0.02	4.95	0.00	2.43	0.22	2.89	0.01	5.55	0.00	0	0	0	0.17	0.18	0	C_2S_1
D. Apa	8.05	525	2.00	3.03	0.20	0.02	5.25	0.06	2.09	0.35	2.75	0.01	5.26	0.00	0	0	0	0.07	0.12	0	C_2S_1
D. May	7.68	435	3.20	0.81	0.24	0.08	4.33	0.00	2.01	0.69	1.63	0.01	4.34	0.18	0	0	0	0.12	0.17	0	C_2S_1
Average	8.09	460	2.37	1.86	0.21	0.03	4.47	0.04	1.87	0.39	2.29	0.01	4.60	0.04	0	0	0	0.17	0.14	0	C_2S_1

TABLE-5
CHEMICAL ANALYSIS RESULTS OF THE WATER SAMPLES COLLECTED IN JULY 2001

Samples	pH	EC×10^6 (25 ºC)	Cations (me L^{-1})					Anions (me L^{-1})						Trace Elements (mg L^{-1})					SAR	RSC me L^{-1}	Qu. Cls
			Ca^{2+}	Mg^{2+}	Na^+	K^+	ΣC	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	ΣA	Fe	Cu	Mn	Zn	B			
LB (ins.)	8.30	465	2.60	1.86	0.15	0.03	4.64	0.17	1.89	0.30	2.25	0.01	4.62	0.00	0	0	0	0.19	0.10	0	C_2S_1
LB (out.)	8.15	410	1.34	2.53	0.18	0.02	4.07	0.13	1.52	1.00	1.43	0.01	4.09	0.00	0	0	0	0.14	0.12	0	C_2S_1
L. Sugla	7.96	478	1.92	2.45	0.36	0.03	4.76	0.00	1.49	1.51	1.74	0.01	4.75	0.00	0	0	0	0.11	0.24	0	C_2S_1
D. Apa	8.10	495	1.30	3.24	0.35	0.04	4.93	0.08	1.85	0.21	2.81	0.01	4.96	0.00	0	0	0	0.04	0.23	0	C_2S_1
D. May	8.06	575	4.50	0.81	0.36	0.07	5.74	0.00	2.39	1.05	2.28	0.01	5.73	0.21	0	0	0	0.09	0.22	0	C_2S_1
Average	8.11	485	2.33	2.18	0.28	0.04	4.83	0.08	1.83	0.81	2.10	0.01	4.83	0.04	0	0	0	0.11	0.18	0	C_2S_1

cm^{-1} (C_2; 250-750 μmhos cm^{-1}) and that's why all of the waters are used in irrigation as safely.

Water specimens had very good characters with respect to Cl^- (chlorine) and SO_4^{2-} (sulphate) anions because they were in class I[26] (0-4 me L^{-1}). It was determined that the quality of Dam Altinapa found in same region water used both in irrigation and drinking of Konya people as class I with respect to Cl^- and SO_4^{2-} ions[27].

The contents of NO_3^- (nitrate) were found to be at trace levels (average 0.01 mg L^{-1}). It was found that the NO_3^- contents of water of Dam Keban situated in north of research[25] area are 2.17-2.85 mg L^{-1}.

On the other hand, B contents of water samples differed between 0.53 mg L^{-1} (Dam Apa) and 0.86 mg L^{-1} (Lake Beysehir inside part). Average value was 0.64 mg L^{-1}. The water samples collected in October 2000 were classified as class II (0.50-1.12 mg L^{-1})[26] with respect to the B contents. These waters must not be used for sensitive plants to B.

It is desired that Ca^{2+} and Mg^{2+} concentrations are higher than Na^+. The SAR (sodium adsorption ratio) is the best important indicator of the relation in between these cations[12]. In the research waters, SAR values ranged between 0.30 (lake Beysehir inside part and outlet) and 0.51 (Dam Apa) and average value was 0.37. That's why; these waters are in the class I (S_1; 0-10) for SAR[28]. Thus, all of the waters can be used in irrigation without any problem.

In addition, all of the water samples were evaluated for RSC (residual sodium carbonate) as Class I (< 1.25 me L^{-1})[26], so they can be used in irrigation as safely.

All the water specimens taken in October 2000 were in quality class II (C_2S_1) and thus they are able to use in irrigation of plants.

Analysis results of January 2001

The analysis results of irrigation water samples collected in January were given in Table-3. The pH values of irrigation water samples were found between 7.50 (lake Sugla) and 8.28 (lake Beysehir outlet). Average pH value was 8.06. The pH values of the samples that have moderate alkaline property were ranged around normal (6.50-8.50) limits. It was determined that the pH values of the lake Sugla water were 7.50-8.20[17].

The EC values of the samples were ranged from 430 μmhos cm^{-1} (lake Beysehir outlet) to 635 μmhos cm^{-1} (Dam May). The average EC value was found as 527 μmhos cm^{-1} and it increased according to analysis in October 2000. This increase might be the result from turbidity because of late autumn and early winter flows. The increase of EC in the irrigation waters limits its usage of water resource in irrigation. That's why; discharge of torrents, drainage waters and sewerage and industry waters to water environments must be prevented[29].

Water specimens had good characters with respect to Cl^- and SO_4^{2-} anions because they were in class I. In generally, irrigation waters in the region have good quality for these anions. It was determined that lake Egirdir water found in the west of lake Beysehir was in class I with respect to in question anions[30].

On the other hand, the B contents of the water samples differed between 0.00 mg L^{-1} (Dams Apa and May) and 0.45 mg L^{-1} (lake Beysehir inside part). Average value was 0.12 mg L^{-1}. The water samples collected in January 2001 were classified as class I (0.00-0.50 mg L^{-1})[26] with respect to the B contents. These waters were safe and usable in irrigation.

The SAR values changed between 0.11 (lake Beysehir inside part) and 0.28 (lake Sugla) and average value was 0.17. That's why; these waters are in the class I for SAR. Thus, all of the waters can be used in irrigation without any problem. It was found that lake Sugla water had 0.29-0.37 SAR values by other researcher[17].

In addition, all of the water samples were evaluated for RSC as Class I (< 1.25 me L^{-1})[26], so they are safe and usable in irrigation practices with respect to RSC.

All of the water specimens taken in January 2001 were in quality class II (C_2S_1) and thus they are safe and usable in irrigation of crops.

Analysis results of April 2001

The analysis results of irrigation water samples collected in April were given in Table-4. The pH values of irrigation water samples were found between 7.68 (Dam May) and 8.40 (lake Beysehir outlet). Average pH value was 8.09. The pH values of the samples that have moderate alkaline property were ranged around normal (6.50-8.50) limits.

The EC values of samples were ranged from 325 μmhos cm^{-1} (lake Beysehir outlet) to 555 μmhos cm^{-1} (lake Sugla). The average EC value was found as 460 μmhos cm^{-1} and according to the results of the earlier periods this decrease might be resulted from spring waters were more and the salt concentration was lower. All of the waters were in class II with respect to EC and so they are safe and usable.

Water specimens had very good characters with respect to Cl^- and SO_4^{2-} anions because they were in class I.

On the other hand, the B contents of water samples differed between 0.07 mg L^{-1} (Dam Apa) and 0.27 mg L^{-1} (lake Beysehir inside part). Average value was 0.17 mg L^{-1}. The water samples collected in April 2001 were classified as class I (0.00-0.50 mg L^{-1})[26] in relation to the B contents. So, these waters were safe and usable in irrigation practices.

The SAR values changed between 0.11 (lake Beysehir inside part) and 0.18 (lake Sugla) and average value was 0.14. That's why; these waters are in the class I for SAR. Thus, all of the waters are safe and usable in irrigation of crops.

In addition, all of the water samples were evaluated for RSC as Class I (< 1.25 me L^{-1})[26], so they are safely usable in irrigation with respect to RSC.

All of the water the specimens taken in April 2001 were in quality class II (C_2S_1) and thus they are safely usable in irrigation of crops.

Analysis results of July 2001

The analysis results of the irrigation water samples collected in July were given in Table-5. The pH values of the irrigation water samples were found between 7.96 (lake Sugla) and 8.30 (lake Beysehir inside part). Average pH value was 8.11. The pH values of the samples that had moderate alkaline property were ranged around normal (6.50-8.50) limits. It was found that the pH of the water sample taken[24] from lake Beysehir in July 1991 was 7.80. The pH value increased (CO_3^{2-} value increased and HCO_3^- value decreased) in 10 years. Now, RSC is not a problem because of the CO_3^{2-} increase.

The EC values of the samples were ranged from 410 μmhos cm^{-1} (lake Beysehir outlet) to 575 μmhos cm^{-1} (Dam May). The average EC value was found as 485 μmhos cm^{-1} and it again increased according to the result obtained in April. This increase might be resulted from decrease of water resources and so the salt concentration increased in the water. All of the waters were in class II with respect to EC and so they are safely usable.

Water samples had good characters in relation to Cl^- and SO_4^{2-} anions because they were in class I.

On the other hand, the boron contents of water samples differed between 0.04 mg L^{-1} (Dam Apa) and 0.19 mg L^{-1} (lake Beysehir inside part). Average value was 0.11 mg L^{-1}. The water samples collected in July 2001 were classified as class I (0.00-0.50 mg L^{-1})[26] with respect to the boron contents. So, these waters were safely usable in irrigation of crops.

The SAR values changed between 0.10 (lake Beysehir inside part) and 0.24 (lake Sugla) and average value was 0.18. That's why; these waters are in the class I for SAR. Thus, all of the waters are safely usable in irrigation.

In addition, all of the water samples were evaluated for RSC as Class I (< 1.25 me L^{-1})[26], so they are safely usable in irrigation in relation to RSC.

All of water specimens taken in July 2001 were in quality class II (C_2S_1) and but yet they are safely usable in irrigation of crops.

Conclusion

It is determined that all of the water samples had moderate alkaline reaction, class II salinity and class I alkalinity (C_2S_1), class I RSC, class I and II B, class I Cl^- and SO_4^{2-} and from lake Beysehir to Dam May along the Canal Çarsamba, nitrate, iron and zinc contents increased and boron contents decreased. In addition, there is not heavy metal pollution in the waters. Anyway, copper and manganese were not found in any of the samples, iron and zinc were found as trace in some specimens. All of the water samples were evaluated as suitable in irrigation with respect to pH, EC, B, SAR, RSC and heavy metal. But, it must be sampled, analyzed and followed by the related offices at certain intervals for every year.

REFERENCES

1. F. Saatçi, Research on Quality of Artesian, Well and Some River Waters Used in Irrigation in Izmir, Manisa, Mugla and Aydin Regions with Respect to Irrigation, (in Turkish), Univ. of Aegean Fac. of Agric. Publ. No: 139, Izmir (1967).
2. I. Kovanci, A Research on Some Properties and Chemical Contains of Inside Aegean Irrigation Waters with Respect to Plant Feeding (in Turkish), Univ. of Aegean Fac. of Agric. Publ. No: 364, Izmir (1979).
3. M. Apan, Evaluation of Irrigation Water Quality (in Turkish), Univ. of Atatürk, Fac. of Agric. Publ. No: 7: 245-256, Erzurum (1976).
4. N. Oruç and T. Saglam, Practice Notes of Soil Chemistry (in Turkish), Univ. of Atatürk, Fac. of Agric., Erzurum (1978).
5. Anonymous, *J. Hazad.*, **38**, 22 (1988) (in Turkish).
6. S. Karakaplan, Notes on Water Quality (in Turkish), Univ. of Selcuk, Fac. of Agric., Konya (1998).
7. H. Degirmenci, *J. Univ. Uludag,* Fac. Agric. Busra, **14**, 35 (1998) (in Turkish).
8. B. Kendirli and B. Benli, *J. Agric. Eng.*, **331**, 14 (2001) (in Turkish).
9. Z. Meng, R. Yu and Z. Wang, *Acta Pedol.*, **21**, 79 (1984).
10. N. Oruç, *J. Univ. Atatürk*, Fac. of Agric. Erzurum, **1**, 77 (1970) (in Turkish).
11. F. Ince, *J. Univ. Atatürk*, Fac. of Agric., Erzurum, **11**, 127, (1980) (in Turkish).
12. T. Demirer, S. Kaleli and U. Simsek, *J. Univ. Selcuk*, Fac. of Agric., Konya, **14**, 11 (2000) (in Turkish).
13. N. Munsuz and I. Ünver, Waters of Turkey, Univ. of Ankara, Fac. of Agric. Publ., No: 822, Ankara (1983) (in Turkish).
14. F. Bayrakli, Water Quality and its Technology, Univ. of Selcuk, Fac. of Agric. Publ., ISBN: 975-448-114-8, Konya (1995) (in Turkish).
15. Anonymous, Report of Seydisehir Sugla Plain Planning Drainage in Konya-Çumra Project, Government Water Works, 4. Region Directorate, Konya (1983) (in Turkish).
16. Anonymous, Closed Basin Soils of Konya, Soil-Water Research Inst. Directorate Publ., No: 288, Ankara (1978) (in Turkish).
17. S.S. Uluatam, Water Quality Assessment of Konya Irrigation Project. Univ. of Çukurova, Fac. of Engineering and Architecture 15, Year Symp., 4-7 April 1994, pp. 97-112, Adana (1994).
18. A.S. Biricik, Structural and Geomorphologic Study of Lake Beysehir Basin, Univ. of Istanbul Publ., No: 2868, Geography Inst. Publ., No: 119, Istanbul (1982) (in Turkish).
19. www.geocities.com/Seydisehir2000/index2.htm
20. M.R. Ertas, Irrigation Guide of Konya Plain Irrigation System, Soil and Water Research Inst. Region Directorate Publ., No: 60, Konya. (1979) (in Turkish).
21. R. Topak, Practice Problems in Sprinkler Irrigation in Konya Çumra Plain, Ph.D. Thesis, Department of Agricultural Buildings and Irrigation Science, Graduate School of Natural and Applied Sciences, Univ. of Selcuk, Konya (1996) (in Turkish).

22. E. Gamsiz and G. Agacik, Water and Analysis Methods, Government Water Works General Directorate Press, Ankara (1981) (in Turkish).
23. M. Ayyildiz, Irrigation Water Quality and Salty Problems, Univ. of Ankara, Fac. of Agric. Publ., No: 879, Ankara (1983) (in Turkish).
24. M. Zengin and F. Bayrakli, *J. Univ. Selcuk*, Fac. of Agric., Konya, **4**, 111 (1992) (in Turkish).
25. E. Duman and N. Özdemir, *J. Univ. Aegean*, Izmir, **8**, 124 (1991) (in Turkish).
26. Anonymous, Main Quality Criterions in Classification of Irrigation Waters, Republic of Turkey Formal Journal, Date: 07.01.1991, No: 20748, Ankara (1991) (in Turkish).
27. A. Kiliçarslan and H. Ürün, A Research on Getting of Konya City Drinking and Use Water from Dam Altinapa, Master Thesis, Department of Building Engineering Science, Graduate School of Natural and Applied Sciences, University of Selcuk, Konya (1984) (in Turkish).
28. J.E. Christiansen, E.C. Olsen and L.S. Willardson, Irrigation Water Quality Evaluation, J. Irrig. Drain. Div. ASCE, 103 (IR 2), 155-169 (1977).
29. M. Polat, Physical and Chemical Parameters Following in River and Lakes. Proceedings of the Seminar on Water Quality Management, Government Water Works General Directorate, 10-13 October 1997, pp. 45-55. Ankara (1997) (in Turkish).
30. H. Ürün and M. Beyribey, Survey of Effect of Egirdir District Centre Wastewaters on Water Quality of Lake Egirdir, Environment 86 Symp., Atatürk Culture Centre, 2-5 June 1986, pp. 1-6. Izmir (1986) (in Turkish).

(*Received*: 22 December 2006; *Accepted*: 18 September 2007) AJC-5877