J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (9): 1299-1315, 2014

EVALUATION OF DRAINAGE WATER QUALITY AND ITS EFFECTS ON SOIL PROPERTIES AND NUTRITION OF PLANTS.

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ABSTRACT

The present study was carried out on EL-Serw drain located between Dakahlia Governorate and Damietta Governorate to evaluate the effect of drainage water quality on chemical composition of soil and plants. EL-Serw drain passes through many villages dotted along it receiving their agricultural drainage water, domestic waste waters and industrial effluents. Water samples were seasonally collected from 6 sites along this drain (the beginning of the drain (0), 5, 10, 15, 20 and 25 km.) during June 2012 to March 2014.

The main obtained results are presented as follows:

- Electrical conductivity (EC) values increased slightly with northward direction. Also, Sodium adsorption Ratio (SAR) took the same trend, the quality of studied drainage water belong to C3 S1 and C4 S2 classes and could be reused in irrigation purpose under special management.
- Boron (B) concentration, at most of locations have low concentration (B1) < 3 mg L^{-1} which less than the critical limit indicating (slight to moderate for restriction on use).
- Nitrate –N concentration was ranged from 5-30 ppm in the EL-Serw drain in two summer season 2012 at distance 0 to5 Km. and 2014 at distance 0 to 10 Km. whereas, the other sites had higher water than the critical limits.
- Micronutrients and heavy metal ions concentrations (Fe^{+2}, Mn^{2+}, Zn^{2+} and Pb^{2+}) were less than permissible levels at all selected water samples.
- Soil salinity and SAR values of soil increased as a result of using drainage water and the increasing of soil pH is related to salt content in irrigation water.
- Using drainage water for irrigation, caused an increase in soil content of available micronutrients (Fe, Mn and Zn) whereas, heavy metals (Pb) was less than the permissible limit (500 mg Kg^{-1}).
- Concentrations of heavy metals and micronutrients (Fe, Mn, Zn and Pb) in straw and grains of wheat and rice grown in the most locations were under the permissible limits except Pb and Fe concentration exceeds the critical levels in all locations.The concentration of heavy metals and micronutrients in straw of wheat and rice crops were higher than in the grain in all locations.
- Zn and Mn concentrations were less than critical limits in all locations in shoot of clover plants and Pb and Fe concentrations were higher than critical limit in all locations.
- Finally, the rice crop slightly affected by water quality than wheat and finally clover.

Keywords: Drainage water, plant chemical composition, soil properties and heavy metals.

INTRODUTION

Due to global population increasing, the gap between water supplies and demands is widening and is reaching such alarming levels that in some parts of the world it is posing a threat to human existence. For human life, water scarcity is not only about droughts or rivers running dry, above all, it is about guaranteeing the fair and safe access they need to sustain their lives and secure their livelihood.

The River Nile is the main source of water in Egypt, with an annual allocated flow 55.5 billion m^3 yr^{-1} according to the Nile waters Agreement of 1959 between Egypt and Sudan. However, the Egyptian population has increased rapidly while, the water reuse didn't change. Consequently, Egypt become under water poverty limit, EL-Hadidi *et al*. (2008).

The drainage water reuse in irrigation was officially and non-officially. Officially reuse is the practice of pumping part of the drainage water flow into the irrigation water system. Physically, officially reuse occurs lifting specified amounts of drainage water for mixing with better water quality canals. Unofficially reuse is practiced by individual farmers who decide, when and how drainage water will be used for supplementing their needs of irrigation water. Unofficially reuse of drainage water normally takes place near the tail ends of the irrigation canals, EL-Komy (2012).

The agricultural drainage water in Egypt is considered one of the most important untraditional water resources. The idea of reusing agricultural drainage water in irrigation started to take considerable place in the water policies, and the used agricultural drainage water was estimated by 4.5 billion m^3yr^{-1} in Delta area (EL-Eshmawiy *et al.,* 2006).

Egypt, especially in the lower zone of the Nile Delta, suffers from numerous types of pollutions. This represents a health hazard and threatens the lives of farmers and other people eating the polluted crops (EL-Sheikh, 2003).

EL-Sheikh *et al.* (2010) evaluated free water surface constructed wetlands (by far the largest application project is named “Lake Manzala Engineered Wetland [Egypt]”) utilized to improve the water quality in Bahr El-Baqar drain, which is located at the northeastern edge of the Nile Delta. They found that the concentrations of contaminants in the effluent were relatively low. The percentages of removal for the different contaminants were BOD_5: 52%, COD: 50%, TSS: 87%, TDS: 32%, NH_4-N: 66%, PO_4: 52%, Fe: 51%, Cu: 36%, Zn: 47% and Pb: 52%.

The government of Egypt has implemented EL-Salam canal project to reuse drainage water from Bahr Hadous and EL-Serw drains after blending with the Nile water to create new communities along the canal and to re-charting Egypt's population map (Hafez, Azza *et al.,* 2008). It is well known that the quality of drainage water resources in Dakahlia province is better than these drains, so it is necessary to extend reusing of this water in irrigation.

Rogers (2001) stated that soil ECe levels had raised to 4.2 dSm^{-1} at the end of the season for the highest salinity irrigation treatment 7.6 dSm^{-1}.

The soils in the two most saline irrigation treatments also became sodic (SAR (1:5) > 3) by the third and fourth seasons. EL-Arby and El-Bordiny (2006) reported that the ECe of soil samples irrigated with waste water are approximately twice those irrigated by Nile water. Gaafer *et al.* (2009) showed that using drainage water (Kafr Dokmiss) in irrigated agriculture land recorded significantly the highest EC, cations and anions concentrations followed by this irrigated with mixed water but this irrigated with Nile water had the lowest values. EL-Komy (2012) pointed that Soil salinity, soluble ions and SAR values of soil increased as a result of using drainage water.

Oron *et al*. (2002); Cetin and Kirda (2003) and Schoups *et al*. (2005) suggested that Long-term sodic-water (SW) irrigation increased soil pH. El-Shahawy and Ragab (2005) examined the pH of El-Gharbia main drain water, the lowest value (7.5) was recorded in August, while the highest value (9.0) was detected in November. Serag (2009) noticed that using drainage water for irrigation resulted in increasing soil pH value. EL-Komy (2012) studied the effect of reuse of drainage water in irrigation on soil pH. He found that the increasing of soil pH is related to salt content in irrigation water.

Therefore, the main objective of this study is to evaluate the effect of irrigation with drainage water on chemical composition of plants.

MATERIALS AND METHODS

Water samples were seasonally collected during Jun. 2012 to Mar. 2014, from six sites in EL-Serw drain along (25 km.), These sites were at distances (0, 5, 10, 15, 20 and 25 km.) from the beginning to end of drain. EL-Serw pumping drainage station in the end of El-Serw, lifts the drainage water to diverse it in EL-Salam Canal. Also, plant samples were taken from crops (rice, clover, corn and wheat) and soil samples irrigated by drainage water were collected seasonally from the beginning to the end of the drain and subjected to chemical analysis.

Water analysis: -

- Salts content expressed as EC values were measured by using electrical conductivity meter, soluble cations and anions were determined according to Jackson (1973).
- Sodium adsorption ratio (SAR) was calculated using Richard's equation (1954).
- NO3 –N was measured using microkjeldahl as described by Hesse (1971).
- Boron was determined calorimetrically using cariumen according to Jackson (1973).
- For determined Pb, Fe, Mn and Zn content in the drainage water of EL-Serw drain, water samples were digested using nitric acid as described in standard methods-302 A (APHA, 1985).

Soil analysis:-

- The available iron, manganese, zinc and lead were extracted using the extracted solution of diethylen triamine penta acetic acid 0.005 M (DTPA), calcium chloride ($CaCL_2$) and triethanol amine, according to Lindsay and Norvell (1978).

- Soil reaction (pH) was measured in saturated soil paste using combined electrode pH meter as mentioned by Richards (1954).
- Total soluble salts were determined by measuring the electrical conductivity in 1:5 soil extract in dSm^{-1} as explained by Jackson (1973).

Plant analysis: -

- Plant samples were dried, ground and digested (0.5 gm) using a concentrated mixture of sulfuric (H_2SO_4) and perchloric ($HClO_4$) acids (1:1) as described by Peterburgski (1968).
- Water, soil and plant samples were measured using atomic absorption to determine of Fe, Zn, Mn, and pb content according to (Page *et al*., 1982).

Crop rotation:

The crop rotations are presented the period of the study in Table 1:

Table 1: Type of plant cultivation during the studying in two drains:

Location km. from start	Type of plant							
	2012			2013				2014
	Jun.	Sep.	Dec.	Mar.	Jun.	Sep.	Dec.	Mar.
0	Rice	Clover	Clover	Clover	Rice	Clover	Clover	Clover
5	Rice	Clover	Clover	Clover	Rice	Clover	Wheat	Wheat
10	Rice	Clover	Wheat	Wheat	Rice	Rice	Wheat	Wheat
15	Rice	Clover	Clover	Clover	Rice	Rice	Wheat	Wheat
20	Rice	Clover	Wheat	Wheat	Rice	Rice	Clover	Clover
25	Rice	Clover	Clover	Clover	Rice	Rice	Wheat	Wheat

Climatic conditions:

The meteorological data were taken from Mansoura meteorological station according to the formal data from the Ministry of Agriculture. Some meteorological data during the period of the study are presented in Table 2:

Table 2: Air temperature, relative humidity during the period of the study.

Year	Month	Temperature C^o		Relative humidity %	
		Max	Min	max	min
2012	Jun.	37	21	78	61
	Sep.	32	23	79	45
	Dec.	21	10	72	52
2013	Mar.	24	7	94	46
	Jun.	31	21	83	55
	Sep.	31	23	89	58
	Dec.	26	11	82	60
2014	Mar.	33	13	88	31

RESULTS AND DISCUSSION

Evaluation of EL-Serw drain water for irrigation purpose:-

The suitability of drainage water for irrigation purpose was determined by salinity, permeability and toxicity problems.

The salinity problem:-

The potential salinity problem caused by salts in EL-Serw drain is evaluated by U.S. salinity laboratory (1954) and FAO (1985). As shown in Table 3 and Fig 1, the drainage water can be classified into two groups as follow; The first group includes water having Ec values ranging between 0.75 to 2.25 dSm^{-1} at the beginning of drain 0 Km) and at the distance 5 Km in all seasons of the study, except Dec. 2013 (2.27 dSm^{-1}) and Mar. 2014. (2.72 dSm^{-1}) This drainage water group belongs to C3-class according to USDA Classification (1954) and is considered to cause increasing salinity problem FAO (1985). Therefore this water cannot be used for irrigation with restricted drainage system. To use this water for irrigation adequate drainage system and special management for salinity control are required and plants with high salt tolerance should be selected. The second group includes water samples having EC values more than 2.25 dS m^{-1} at the end of drain in Jun.2012, at distance 10 Km to the end of drain in Sep., Dec. 2012 and Mar. 2013, at distance 20 Km and the end of drain in Jun. and Sep. 2013 and Mar. 2014, at distance 5.0 Km to the end of drain in Dec. 2013. This drainage water group belongs to C4-class according to USSL classification and not suitable for irrigation under ordinary condition but may be used occasionally under very special circumstances.

Generally, EC values were higher in winter months than in summer. EC values were slightly varied from season to another, where the EC values were gradually increased from the beginning to the end of drain. The increase of EC in winter than in summer may be due to the winter closure period where the supply of irrigation water to the main canals is stopped or low during this period. Also, the salinity of drainage water is lower in summer than in winter, probably because of large amounts of water discharged to the drains according to large area cultivated by rice crop. Increasing in EC values were recorded with the clover follow wheat then cotton and finally, rice.

The permeability problem:-

Permeability problem is related to water infiltration into and through the soil profile. The soil permeability is related to the effect of sodium concentration in irrigation water. As shown in Table 3 and Fig.2, drainage water samples of EL-Serw drain can be classified according to the values of SAR into two groups. The first group includes drainage water having SAR value less than 10 ppm at the beginning of drain to distance 5 Km except Dec. 2013, at distance 10 Km. in Jun. 2013 and Mar. 2014 and at distance 15 Km. in Jun. 2012. This first group belongs to S1-class and it can be used for irrigation in all studied location with little adverse effect of the development of harmful levels of exchangeable Sodium (Richard, 1954) and it can be used without any restriction according to FAO (1985). The second group includes drain water having SAR values between 10-15 ppm in the end of El-Serw drain.

According to USDA (1954) water of the studies sites is entirely S1-class. The description of this class "alkalinity hazard" of water as low concentration of sodium thus, this water can be used for irrigation in most months, with adverse effects when using. However, sodium sensitive crops may accumulate injurious amounts of sodium.

Table 3: water chemical analysis and evaluation of EL-Serw drain during the studied period from Jun. 2012 to Mar. 2014.

Distance km. from start	**2012**			**2013**				**2014**
	Jun.	**Sep.**	**Dec.**	**Mar.**	**Jun.**	**Sep.**	**Dec.**	**Mar.**
EC dS m^{-1}								
0	1.55	1.81	1.96	1.68	1.58	1.95	2.09	1.75
5	1.71	2.03	2.15	2.14	1.82	2.14	2.27	2.72
10	2.30	2.45	2.64	2.47	2.87	3.09	3.32	2.87
15	2.65	2.76	2.95	2.59	3.13	3.15	3.86	3.07
20	3.02	3.64	3.87	3.59	3.31	3.66	4.05	3.64
25	3.29	3.73	4.41	3.76	3.59	4.32	4.36	3.93
SAR								
0	9.41	9.56	9.66	9.67	9.30	9.48	9.62	9.36
5	9.71	9.83	9.98	9.79	9.90	9.96	10.37	9.73
10	9.71	10.50	10.01	10.09	10.09	10.46	10.89	9.98
15	9.96	10.96	11.53	11.52	10.67	10.54	12.17	10.47
20	10.67	11.00	12.08	12.10	11.20	11.51	12.26	11.28
25	10.81	11.07	12.70	12.33	11.56	12.36	12.69	12.02
B ppm								
0	0.88	1.37	1.90	1.34	0.83	1.43	1.71	1.18
5	0.95	1.40	1.98	1.38	0.88	1.50	1.78	1.26
10	0.98	1.47	2.03	1.44	0.90	1.53	1.84	1.33
15	1.04	1.49	2.08	1.49	0.96	1.59	1.90	1.38
20	1.08	1.56	2.10	1.52	1.01	1.61	1.99	1.44
25	1.16	1.62	2.19	1.61	1.11	1.76	2.11	1.51
NO_3^- ppm								
0	26.0	36.5	40.0	35.7	25.8	34.1	36.6	30.4
5	27.6	38.1	40.3	36.1	26.9	34.7	37.4	31.3
10	31.8	40.6	42.5	38.6	29.6	37.2	40.3	32.6
15	32.8	41.0	42.8	39.5	30.4	38.6	41.3	32.8
20	33.7	41.3	43.4	40.3	31.1	39.4	43.1	32.9
25	33.9	41.9	43.9	41.0	31.7	39.8	43.5	33.1

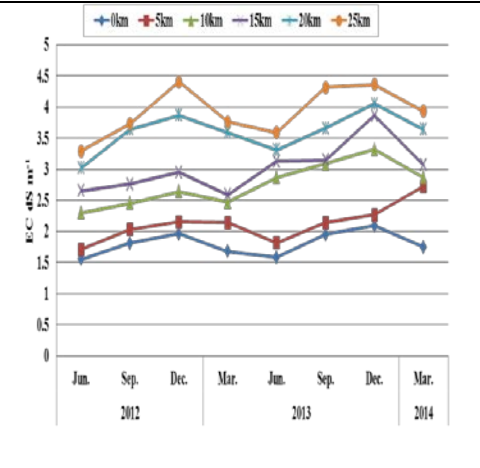

Fig. 1: EC dS m^{-1} values for EL-Serw drain water.

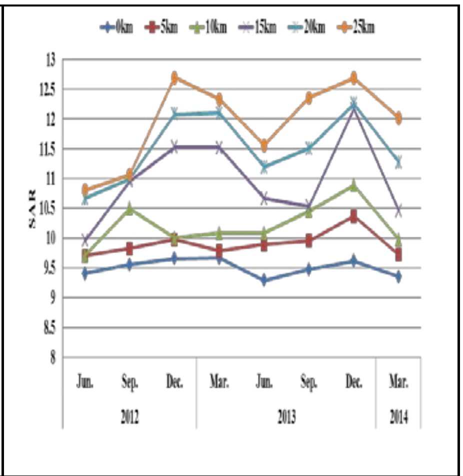

Fig. 2: SAR values for EL-Serw drain water.

The toxicity problem:-

Boron toxicity problem:-

Data presented in Table 3and Fig 3 show that boron concentration in the drainage water varied between 0.83 and 2.19 ppm and B concentration in the water generally was increased with increasing salts content. According to Gupta (1979) who classified irrigation water into five classes on the basic of Boron hazard, this water belongs to class B1< 3 ppm "normal water" in all studied sites. This water can be used for most of tolerant and semi-tolerant crops on all soil without any injuries effects on the grain yield. According to FAO (1985), this water can be classified as slight to moderate degree of restriction on use.

Fig. 3: B ppm values for EL-Serw drainage water.

Nitrate toxicity problem:

As shown in Table 3 and Fig. 4 Drainage water samples of EL-Serw drain can be classified according to NO3–N into two groups. The first group was between 5-30 mg L^{-1} at the beginning of the drain (0 Km.) in Jun. 2012 and 2013, at the distance 5 Km. also in Jun. 2012 and 2013 and at distance 10 Km. in Jun. 2013, it can be used in irrigation but with special conditions. The second group was more than 30 mg L^{-1} and it cannot be used in irrigation because severity degree of restriction on use, According to the guideline of FAO (1985).

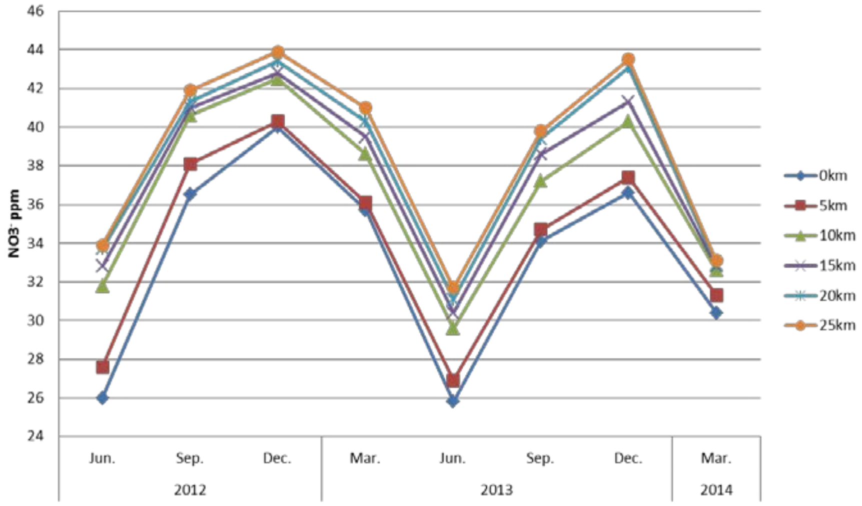

Fig. 4: NO_3^- ppm values for EL-Serw drainage water

Micronutrients and Heavy metals toxicity problem:

The concentrations of Fe, Mn, Zn and Pb were slightly increased in beginning of El-Serw drain to the end of the drain as shown in Table 4 and Figs 5, 6, 7 and 8. According to FAO (1985) and NAS/NAE (1972) the values of Fe and Pb concentrations of EL-Serw drain were less than the critical limits (5 and 5 mg L^{-1}) at all sites of the study in all seasons, whereas, Mn and Zn were less than the critical limits (0.2 and 0.2, respectively), except Zn at the end of the drain (site 25 Km) in Dec., 2013 were higher than the critical limits. In general, the concentrations of these elements were lower in the summer than the winter and less than critical levels in both winter and summer seasons. This water can be used for irrigation purposes without causing serious problems for plants and soil in short term. But, continuous use, especially in summer may cause an accumulation of these metals in plant tissues and soil profile and may lead to toxicity problems.

Table 4: Seasonal variations of micronutrients and heavy metal (µg L^{-1}) in EL-Serw drain during the studied period from Jun. 2012 to Mar. 2014.

Distance km. from start	2012			2013				2014
	Jun.	Sep.	Dec.	Mar.	Jun.	Sep.	Dec.	Mar.
Fe µg L^{-1}								
0	48	50	74	48	44	65	79	50
5	48	57	96	49	45	80	91	59
10	59	72	96	66	64	92	99	80
15	88	92	101	89	87	97	113	93
20	95	97	123	93	96	102	150	104
25	102	109	135	100	105	115	172	114
Mn µg L^{-1}								
0	14	16	19	15	15	17	24	14
5	22	24	26	24	25	36	45	35
10	36	39	46	42	38	43	51	53
15	48	55	80	54	49	69	90	63
20	68	76	96	94	71	82	115	108
25	99	105	118	109	109	112	130	111
Zn µg L^{-1}								
0	14	16	17	21	13	29	39	25
5	35	44	58	48	37	47	68	54
10	67	77	84	75	72	83	93	81
15	80	95	113	105	90	95	155	131
20	110	114	150	112	129	120	201	119
25	161	126	175	125	146	131	216	133
Pb µg L^{-1}								
0	68	70	78	69	70	72	81	71
5	82	85	94	83	84	88	96	86
10	90	104	116	100	90	104	103	99
15	192	212	232	202	195	224	245	109
20	214	245	285	225	215	254	299	235
25	329	335	355	327	332	345	412	365

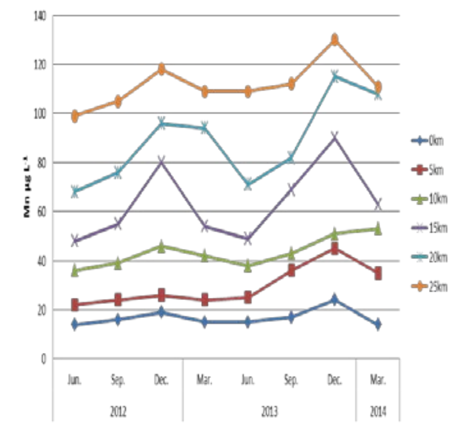

Fig. 5: Mn µg L^{-1} values for EL-Serw drainage water.

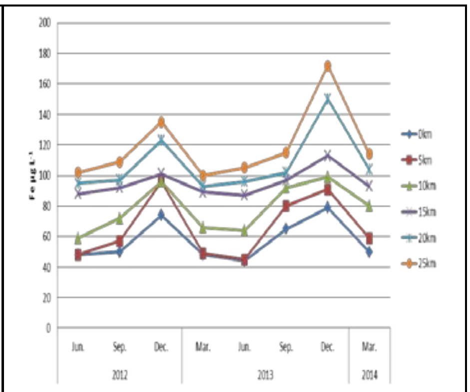

Fig. 6: Fe µg L-1 values for EL-Serw drainage water.

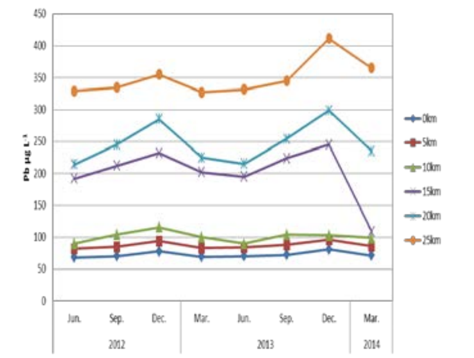

Fig. 7: pb µg L^{-1} values for EL-Serw drainage water.

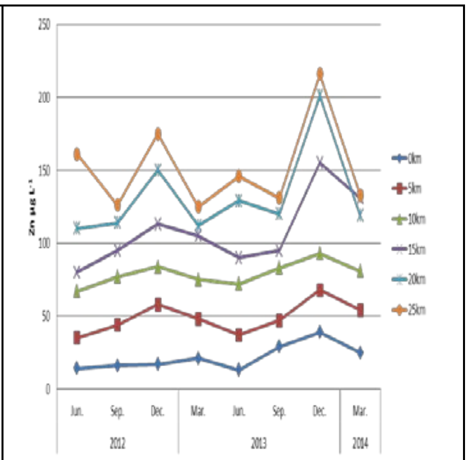

Fig. 8: Zn µg L^{-1} values for EL-Serw drainage water.

Effect of irrigation with drainage water on soil properties:

The soil salinity is mainly due to the salt concentration of applied water in the top soil, the effect of ground water, temperature during the growth season, applied fertilizers and the of irrigation method also cause more salt accumulation, (Ayers and Westcott, 1985).

Soil salinity:

The quality of irrigation water affects soil chemical properties, which could in turn reduce the suitability of the soil as a media for plant growth. It is obvious from data presented in Table 5 that the electeroconductivity (EC_e) of the studied soil varied from site to site, depending on the organic chemical composition on the soil and the quality of irrigation water use. The obtained data showed that utilization of low quality water for irrigation purposes led to increase EC_e value. This increase was almost proportional to the salt concentration ($ECiw_)$ of the irrigation water. These results are in agreement with those obtained by Serag (2009), Kheir (2010), EL-Komy (2012) and EL-Samet (2013). They reported that increasing salinity of applied water or using poor water quality of irrigation caused an increasing in soil salinity.

Soil pH:

Concerning change of soil pH as affected by quality of irrigation water, the data in Table 5 revealed that the pH value ranged from 7.75 to 8.23, the increasing of soil pH is related to salt content in irrigation water. Similar results were found by EL-Komy (2012) and EL-Samet (2013).

Sodium Adsorption Ratio (SAR):

The values of SAR are shown in table 5 indicated that SAR values of soil irrigated with low quality of water were higher than those in soil irrigated with fresh water . These results could be supported by those obtained by (Kheir, 2010).

Table 5: Properties of the studied soil under irrigation by drainage water.

Distance km. from start	2012	2013	2014
	pH		
0	7.75	8.14	8.17
5	7.89	8.17	8.15
10	8.00	8.21	8.09
15	8.09	8.23	7.99
20	7.98	8.14	7.91
25	7.79	8.11	7.85
	EC dSm-1		
0	1.98	2.09	1.99
5	1.94	2.05	2.09
10	1.86	1.95	2.15
15	1.79	1.89	2.10
20	1.71	1.84	1..99
25	1.69	1.79	1.92
	SAR		
0	6.41	6.78	7.30
5	6.33	6.83	7.17
10	6.19	6.57	7.10
15	6.03	6.17	7.09
20	6.01	6.02	7.03
25	5.94	5.97	6.98

Micronutrients and heavy metals contents in soils irrigated directly from EL-Serw drain:-

The effect of low quality water on available of heavy metal (Pb) and micronutrients (Fe, Mn and Zn) of soil are presented in Table 6. Which varied between 1.04 – 4.44, 5.16 – 32.36, 13.5 – 782.0 and 2.5– 61.3 ppm, respectively. Data showed that, using low quality for irrigation led to increase available soil micronutrients, whereas, heavy metal (Pb) was decreased. This is may be due to increase soil salinity and change of soil pH Table 5. Generally, concentration of heavy metal and micronutrients in soil depend on some factors, such as total concentration of elements, type of cultivated plants, pH, total $CaCO_3$, organic matter and soil texture (Wild, 1988). Data in Table 5 showed that, the availability of above mentioned elements varied from site to site but it slightly varied for Fe, Zn and Pb and greatly varied in Mn between sites. The all concentrations were above permissible limit except Pb.

Generally, the long term application of poor quality and polluted drainage water increase the availability and contents of heavy metals and may play a very bad role in the contamination and degradation of agriculture soil.

Table 6: Micronutrients concentration and heavy metals in irrigated soil from drainage water during the studied period from June. 2012 to Mar. 2014.

Distance km. from start	2012			2013				2014
	Jun.	Sep.	Dec.	Mar.	Jun.	Sep.	Dec.	Mar.
Fe mg kg^{-1}								
0	5.16	23.56	6.35	10.23	5.38	6.12	7.08	7.89
5	10.37	29.50	7.15	13.36	7.06	21.83	25.46	28.24
10	7.24	24.83	29.70	18.81	6.49	18.37	18.64	8.76
15	12.93	28.02	29.38	28.62	8.25	12.93	28.25	23.89
20	5.69	7.67	18.78	19.13	6.59	6.30	28.43	20.22
25	13.18	31.02	31.95	30.12	12.26	23.56	32.36	30.25
Mn mg kg^{-1}								
0	30.3	75.6	65.9	61.6	13.5	85.3	73.5	23.5
5	114.6	105.0	102.8	115.4	81.4	106.8	74.6	27.4
10	30.8	127.4	71.4	144.8	26.8	160.6	167.6	26.0
15	94.8	118.4	153.2	74.4	22.0	782.0	84.2	29.2
20	80.2	83.4	67.0	81.8	18.6	87.6	78.6	27.4
25	95.6	99.6	112.6	98.4	98.9	102.5	125.9	103.4
Zn mg kg^{-1}								
0	3.9	4.6	3.2	4.9	3.1	24.5	16.8	29.1
5	6.1	6.9	5.1	16.9	3.4	26.7	58.3	29.3
10	5.9	5.1	8.7	5.9	3.1	18.7	16.3	33.5
15	4.7	7.5	8.1	19.7	3.5	31.9	35.1	31.9
20	3.9	4.3	3.3	13.7	2.5	23.9	21.3	37.5
25	6.8	7.4	9.2	17.1	6.5	32.5	61.3	32.1
Pb mg kg^{-1}								
0	1.04	1.12	1.24	1.09	1.25	1.68	1.69	1.16
5	2.56	2.52	3.22	2.46	2.64	3.28	3.94	2.74
10	2.28	2.46	2.52	2.58	2.52	2.60	4.02	2.62
15	2.76	3.20	2.50	2.84	2.62	2.72	3.66	2.64
20	2.72	2.98	2.92	2.72	2.64	2.72	3.70	2.38
25	2.81	3.35	3.46	2.95	2.86	3.26	4.44	3.21

Micronutrients and heavy metals in plants irrigated from drainage water:

The contents of heavy metals pb and micronutrients (Fe, Mn and Zn) in plants grown in the soil irrigated with drainage water were effected by total and available concentrations of these elements in soil, soil pH and plant species.

Wheat and rice crops:

Data in Table 7 show that the concentration of heavy metal pb and micronutrients (Fe, Mn and Zn) in straw of wheat and rice crops, the data indicated that the concentration of these elements were higher in wheat than rice. the concentration of heavy metals in straw of wheat and rice was higher than in grains Concerning Mn and Zn concentration in straw of wheat plant, were less than the critical limit in all locations.

Table 7: Micronutrients concentration and heavy metal in irrigated plant from drainage water during the studied period from June. 2012 to Mar. 2014.

Distance km. from start	2012			2013						2014	
	Jun.	Sep.	Dec.	Mar.		Jun.	Sep.		Dec.	Mar.	
Fe ppm											
0	1153 R	2631 C	2562 C	2351 C		1356 R	2789C		1654 C	2451 C	
5	1323 R	2965 C	3365 C	2956 C		1398 R	3251C		1854 W	215WS	51 WG
10	1347 R	7620 C	1726 W	495WS	196WG	1962 R	463RS	56RG	1971 W	569WS	236WG
15	1752 R	7960 C	5691 C	3210 C		2215 R	568RS	75RG	2354 W	654WS	321WG
20	2856 R	8126 C	2969 W	553WS	326WG	2964 R	621RS	76RG	7564 C	4251 C	
25	3500 R	8351 C	7365 C	5231C		3618 R	632RS	76RG	3654 W	685WS	336WG
Mn ppm											
0	109 R	132 C	65 C	54 C		115 R	144 C		78 C	49 C	
5	123 R	168 C	76 C	59 C		126 R	175 C		82 W	24 WS	6.52WG
10	145 R	214 C	75 W	55 WS	5 WG	156 R	89 RS	11 RG	91 W	52 WS	8.21WG
15	165 R	315 C	89 C	68 C		173 R	91 RS	11 RG	102 W	61 WS	9.36WG
20	170 R	325 C	87 W	67 WS	6 WG	179 R	98 RS	12 RG	112 C	56 C	
25	167 R	365 C	98 C	75 C		182 R	112 RS	13 RG	108 W	65 WS	9.89WG
Zn ppm											
0	89 R	82 C	92 C	89 C		91 R	95 C		109 C	125 C	
5	182 R	96 C	121 C	115 C		112 R	105 C		129 W	100 WS	37 WG
10	196 R	98 C	110 W	85 WS	33 WG	195 R	75 RS	10 RG	136 W	121 WS	45 WG
15	226 R	121 C	145 C	132 C		209 R	79 RS	10 RG	146 W	125 WS	54 WG
20	296 R	123 C	125 W	96 WS	56 WG	223 R	86 RS	11 RG	271 C	156 C	
25	312 R	168 C	178 C	171 C		246 R	91 RS	12 RG	152 W	132 WS	59 WG
Pb ppm											
0	5 R	15 C	18 C	16 C		6 R	17 C		20 C	17 C	
5	6 R	18 C	20 C	17 C		8 R	19 C		14 W	10 WS	1.95WG
10	8 R	20 C	14 W	10 WS	2.01WG	12 R	7 RS	1.01RG	18 W	15 WS	2.19WG
15	11 R	21 C	23 C	21 C		14 R	9 RS	1.05RG	21 W	17 WS	2.23WG
20	16 R	25 C	16 W	11 WS	2.09WG	16 R	10 RS	1.09RG	29 C	22C	
25	19 R	29 C	28 C	25 C		19 R	11 RS	1.12RG	27 W	23 WS	2.29WG

R= Rice RS= Rice straw RG= Rice grain C= Clover W= Wheat WS= Wheat straw WG= Wheat grain

Pb and Fe concentrations in straw of wheat and rice plants were higher than the critical limit in all locations. This may by due to concentrations of these elements in irrigation water and cultivated soil according to Alloway (1995). The maximum Pb limit, for human health has established for edible parts of crop by WHO (1989) Standard, was 0.3 mg kg^{-1} (Codex, 2001).

Clover plant:

Data in Table 7 show that, Zn (20 ppm) concentration was higher than the critical limits at all locations and Pb (20 ppm) concentration was less than critical limits in shoot of clover plants except Pb at the end of drain in autumn and winter 2012 at distance 15 Km. to the end of drain, winter 2012 at distance 20 Km., spring 2013 at distance 15 and 25 Km. and spring 2014 at distance. 20 Km was higher than the critical limits. While, Fe concentration was higher than critical limit at all locations according to **Alloway (1995).**

On the other hand Mn concentration was less than critical limit (400-1000 ppm) at all locations in shoot of clover plants. It was found that pb concentration in fresh clover yield irrigated with drainage water was higher than the normal level.

The order of micronutrients and heavy metal concentration were as follows:

Clover > Wheat > Rice

Finally, the concentration of the previous element in wheat (straw & grain), rice (straw& grain) and clover plants affected by irrigation water quality and fertilizers, total and available concentration of these element in soil, soil pH and plant species.

CONCLUSION

To safe reuse of the drainage water in irrigation it can be concluded that:-

- This water can be used at the head of the drains where the salinity levels of waters were approximately low.
- This water can be used in the summer season compared to winter season, spring season and autumn season where EC, SAR, B, and NO_3 increased to ward the north direction from the beginning of drain to the end of drain.
- The water at the end part of the studied drain is not suitable for irrigation during the period of study (2012 to 2014).
- Proper management for water, soil and plant is required to maximize the utilization of drainage water efficiency and minimize the adverse effects. The soil must be permeable, drainage must be adequate, and irrigation water must be applied in excess amount to provide the leaching requirement and high salt tolerance crops should be selected.

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تقييم نوعية مياه الصرف وآثاره على خواص التربة وتغذية النبات

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أجريت هذه الدراسة علي مصرف السرو والواقع بين محافظتي الدقهلية ودمياط حيث يمر خلال العديد من القرى التي تنتشر علي طول المصرف. تستقبل مياه الصرف الصحي، ومخلفات المنازل والنفايات السائلة وطوله ٢٥ كم حيث تم تجميع عينات المياه موسميًا من يونية ٢٠١٢ حتى مارس ٢٠١٤ على مسافات من بداية المصرف (٠، ٥، ١٠، ١٥، ٢٠ و ٢٥ كم) وأيضًا تم أخذ عينات أرضية ونباتية موسميًا على طول المصرف.

وكانت أهم النتائج المتحصل عليها:

- أظهرت قيم التوصيل الكهربي (EC) لعينات مياه الصرف زيادة طفيفة مع الاتجاه شمالاً حتي الوصول لنهاية المصرف كذلك نسبة الصوديوم المدمص (SAR) أخذت نفس الاتجاه وعليه صنفت كل عينات المياه في كل المواقع في رتبة C3S1 ما عدا عينات المياه عند نهاية المصرف وقعت في رتبة C4S2 .
- بالنسبة لتركيز البورون ، اوضحت النتائج أن تركيزه في كل المواقع كان أقل من ٣ مليجرام / لتر (B1) تحت الحدود المسموح بها لذا درجة استخدامها تكون خفيفة إلي معتدلة.
- يتراوح تركيز النترات في مباه مصرف السرو بين ٥ – ٣٠ مليجرام / لتر في موسمي صيف ٢٠١٢ عند مسافة صفر و٥ كم و صيف ٢٠١٤ عند مسافة صفر حتي مسافة ١٠ كم بينما المواقع و المواسم الأخرى كانت أعلي من الحدود المسموح بها.
- تركيز العناصر الدقيقة والرصاص أقل من الحدود المسموح بها في كل مواقع اخذ عينات المياه.
- ملوحة التربة و قيم SAR تزيد مع زيادة استخدام مياه الصرف فى الرى كما أن زيادة الـ pH فى التربة مرتبط بمحتوى مياه الرى من الأملاح ونوعيتها.
- ادي استخدام مياه الصرف في الري إلي زيادة محتوي التربة من العناصر الدقيقة بينما عنصر الرصاص كان أقل من الحدود المسموح بها (٥٠٠ ملجم/ كجم).
- تركيز العناصر الدقيقة والرصاص في قش وحبوب نباتات القمح والأرز في معظم المواقع كانت أقل من الحدود المسموح بها ما عدا الحديد كانت أعلي من الحدود المسموح بها. أيضاً تركيزات هذه العناصر في قش القمح والأرز كانت أعلي من الحبوب في كل المواقع .
- تركيزات الزنك و المنجنيز كانت أقل من الحدود المسموح بها في كل المواقع في نبات البرسيم بينما تركيزات الحديد والرصاص كانت أعلي من الحدود المسموح بها في كل المواقع طول فترة الدراسة.
- نبات الأرز كان أقل المحاصيل تأثراً بجودة المياه يليه القمح ثم البرسيم.

J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (9): 1299-1315, 2014