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INFLUENCE OF WATER TABLE FLUCTUATION IN THE TAIL OF DRAINS AND IRRIGATION CANALS ON CHEMICAL AND PHYSICAL PROPERTIES OF SOIL IN THE NORTH NILE DELTA REGION

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ABSTRACT

The objectives of the present study were to determine the fluctuation effect of water table level in tail ends of drains and irrigation canal on chemical and physical properties of the soil in North Nile Delta region. Six soil profiles from Kafr El-Sheikh were excavated at each location in two lines under investigation. The studied area is located between EL-Gharbia main drain and Nashart drain, since it was started from Kafr El-Sheikh towards the Mediterranean Sea in the north for the first line. Three locations were chosen on Nashart drain at a distance of 5, 10 and 20 km from Burullus Lake towards Sedi-Salim district. The second line of study was EL-Gharbia main drain. Three locations were selected on a distance of 5, 20 and 30 km from the sea towards Kafr- El-Sheikh city.

Three observation wells at 10, 50 and 100 meters distance for each profile were installed and the fluctuation of water table depths were recorded, table fluctuation of water were recorded.

The obtained results illustrated that the values of hydraulic conductivity increased with increasing depth of water table level. Also, data revealed that the values of hydraulic conductivity decreased with decreasing the distance from the sea and increased with increasing the distance from the drain. Data showed that the fine clay content (<1μ) increases in the 30-90 cm layer, while in shallow water table profiles the aggregation parameters were decreased due to fluctuation of water table level.

The values of electrical conductivity, SAR, ESP, pH, soluble cations, anions and total calcium carbonate in the studied soil, were increased gradually towards the tail of the drains and water irrigation canals due to reuse of drainage water and the intrusion of sea water with groundwater. Cation exchange capacity (CEC) decreased gradually towards the tail of drains and irrigation canals, and increased with increasing water table depth.

These results declared that the values of organic matter increased when the distance was far from the tail ends of drains and irrigation canals and decreased with shallow water table profiles, while the values of NPK increased with increasing the distance from Burulls Lake due to increasing of groundwater salinity.

Keywords. Burulls Lake, Nashart drain, intrusion, fluctuation.

INTRODUCTION

Farmers at the tail –end of irrigation canals, unofficially reuse about 2 billion m3/y of drainage water, directly for irrigation (EL-Hessy and EL-Kady, 1997). Use of low water quality for long time led to several adverse effects on soils and plants. Soil salinity of Nile North Delta is considered the major exclusive problem for agriculture production. About 60 % of its area (about 2 million feddan) especially in North Nile Delta is salt affected soils (FAO, 1995). The water table in the agriculture lands of North Nile Delta has a fluctuating nature which rises due to recharge by excessive irrigation, back drains, canal seepage, seepage from high lying lands and shallow barrier and falls due to evapotranspiration or lateral and deep seepage. When the rate of recharges exceeds the rate of seepage, there is always a rising trend in water table levels. The shallow water table reduces the plant growth due to decrease of rooting volume and insufficient oxygen.

The values of soil volumetric water content, bulk density, and soil strength increased while the values of saturated hydraulic conductivity, soil porosity decreased with a depth of water table (Aust *et al.*, 1993). The differential values of hydraulic conductivity close to Burullus Lake are attributed to the variation in soil texture, type of clay minerals, water table depth, soil stratification, soil salinity and soil alkalinity (El-Melegy, 1995). The soils at the surface and near the crop-root zone had very low clay content, low water holding capacity and high saturated hydraulic conductivity. The increase in clay % and bulk density (Db) with decrease of HC values at deeper layers could be attributed to the continuous shallow water table environment (Rao Mylavarapu and Subodh Achorya, 2010). Total and fine clay increased in subsurface horizons under paddy soils conditions (Abo Waly *et al.* 1994). The quality of drainage water in Kafr EL-Sheikh Governorate was located from C3-S1 to C4-S3 classes according to USDA**(**Richards, 1954). The drainage water could be re-used in irrigation purposes under special managements or for leaching the highly saline soils (Abo Waly *et al.* 1994). Results obtained by (Khan *et al.*, 2011) showed that minimum irrigation intensities must be met to flush salts out of the root zone especially in shallow water table/high salinity impact areas. Such minimum irrigation intensities are helpful but not necessarily in deep water table/low salinity impact areas**.** The average of CEC values, for profile in middle delta between 46 to 64 meq /100 g soil. It is remarkable that these values increased towards north direction also it increased in the water table affected layers especially profile with high water table (Nageeb, 1995). Also, it was found that water table affected layers in shallow water table depth contains high values of organic matter than that affected water table layers in deep or moderately deep of water table depth. The residual nutrients contents of nitrogen, potassium and phosphorus increased as salinity levels increased indicating the reduced ability of ground nutrients uptake under high saline conditions.

MATERIALS AND METHODS

A number of 18 observation wells were installed to measure the movement and fluctuation of water table levels in these locations. Six soil profiles were excavated at each location of two lines under investigation, soil samples were taken at from a depth of 0-150 cm to determine chemical and physical soil properties from Kafr El-Sheikh Governorate. Soils samples from the different locations were collected to represent some soils in North Nile Delta in Egypt affected with water table (Fig.1). These locations were chosen to cover as far as possible the following soils affected with water table due to water level in the drains :

A- Nashart Drain:

1- EL-Ghanamen.
2- EL-Balasy.
3- EL-Kawasem.

B- EL-Gharbia main Drain:

4- Kafr-Dokhmes.
5- Village 7.
6- Hamad.

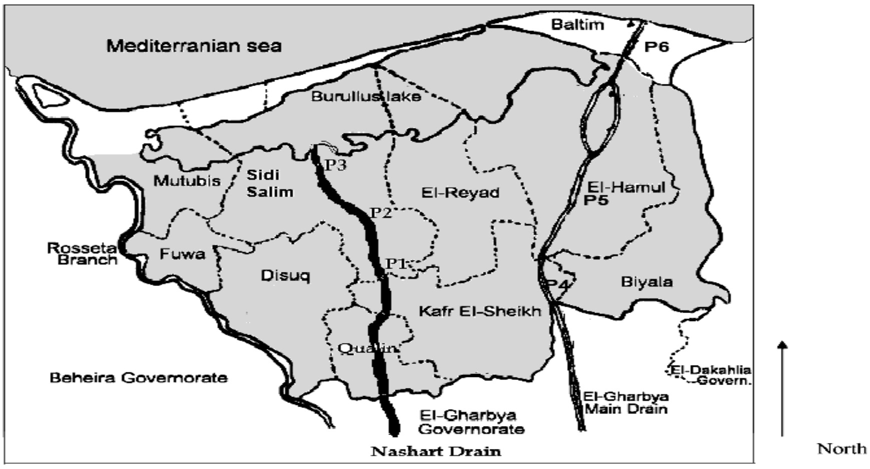

Figure 1. Location of the soil profiles studied. Scale 1:7500.

Table (1): The location of the studied soil profiles and its coordinates.

Location	Coordinates	
	Lat	Long
Nashart drain		
P1 ELGHANAMEN	31° 15′ 57″	30° 47′ 6″
P2 ELBALASY	31° 17′ 48″	30°4′ 730″
P3 ELKAWASEM	31° 20 ′ 18″	30°46′ 12″
El-Gharbia drain		
P4 KAFR DOKHMES	30° 8′ 01 ″	30° 03′ 5″
P5 VILLAGE 7	31° 24′ 48″	31°10′ 48″
P6 HAMAD	31° 34′ 12″	31°10′ 47″

The soil samples were air-dried, gently crushed, passed through a 2-mm sieve. Some chemical and physical properties of the soil samples were determined according to Page (1994). Bulk density was determined using metallic cylinders as g cm^{-3} (Black, 1965). Aggregation parameters were determined as reported by Baver *et al.* (1972). Hydraulic conductivity by the auger hole in the field according to Van Beers (1970). The EC of soil was measured in the soil paste extract by electrical conductivity meter (Model 4320

JENWAY), the pH was measured in 1: 2.5 soil-water suspension by pH-meter (Model 420 A), total $CaCO_3$ by Collins calcimeter and O.M. by Walkly and Black method. The particle size distribution (Sand, Silt and clay) was determined by pipette method for fine fraction (Gee and Bauder, 1986). Available nitrogen was extracted using 2M KCl and determined by the micro-kjeldahl method (Keeney and Bremner, 1966), available phosphorus was extracted using sodium bicarbonate and determined by spectronic Milton Roy by (Olsen, *et al.*1959) and available potassium was extracted using ammonium acetate at pH 7 and determined by Flame photometer (Klute 1986). The fluctuation and movement of water table in observation wells were measured by the sounder.

RESULTS AND DISCUSSION

Effect of water table fluctuation in the tail of drains and irrigation canals on physical and chemical properties of the soil:
Nashart drain:

Some soil physical properties of the studied soil profiles are presented in Table (2). Data showed that the mean values of hydraulic conductivity ranged between 0.52-0.86 m/day in profiles No. 3 and 1, respectively, these values classified as moderately class according to (O'Neal, 1952). The highest value was recorded in profile No.1 due to the lowering depth of water table. While the low value was recorded in profile No. 3 due to increasing the concentration of sodium ions in adjacent tail of drains. The values of soil bulk density ranged between 1.30-1.47 g cm^{-3}, low variation in these values also increased with depth in shallow water table depth in (profile No.1). These results are in agreement with those obtained by Nageeb (1995).

Regarding the particle size distribution, most of studied soil profiles were nearly similar in three texture classes which are clay texture. Data showed that the fine clay content (<1μ) increases in the 30-90 cm which could be rendered to effect of water table fluctuation due to back drains and increased in shallow water table profiles than deeper water table profiles such as profile No.1 (Abo-waly, 1994). Data presented in Table (3) showed that the aggregation parameters, such as water table aggregates (WSA %), optimum size aggregates (OSA), mean weight diameter (MWD), aggregation index (AI) and structure coefficient (SC) of the studied soils, decreased in direction of Burullus lake and the Mediterranean sea due to increasing of groundwater salinity and sodicity parameters of soil structure decreased in shallow water table profiles than deeper water table profiles especially profile No.(1).

Regarding soil chemical properties of the studied soil profiles are presented in Table (4). The mean values of soil salinity ranged between 5.28 to9.68 dS m^{-1} at 25 C° in profiles No. 1 and 3, respectively, the remarkable increase of soil salinity values towards the tail ends due to reusing drainage water and seepage from Burullus Lake, in spite of the fluctuation of water table in profile No.1. While soil salinity is low due to irrigating with Nile water from EL-Sheikh Ibrahim branch canal sometimes due to leaching processes. Data showed that the values of, SAR, ESP, pH, soluble cations, and anions were increased with distance from tail ends and drains, the highest values were recorded in profile 3 and the lowest values were observed in profile 1 due to increasing of groundwater table salinity, concentration of sodium ions and traditional agricultural practices (El-Hamashary *et al.*1992).

Table (2): Some physical properties of the investigated soil profiles.

Profile No	Depth, cm	Bulk Density gm cm^{-3}	Hydraulic conductivity (H.C. m/day) Distance from drain				Particle size distribution Clay % from the total					
			10 m	50 m	100 m	Mean	Coarse >1µ	Fine <1µ	Clay %	Silt %	Sand %	Soil texture
1	0-30	1.32	0.35	0.56	0.67	0.53	61.16	38.84	47.46	36.48	16.06	clay
	30-60	1.33					58.1	41.90	47.54	39.80	12.66	Silt clay
	60-90	1.44					25.43	74.57	61.56	24.35	14.09	clay
	90-120	1.57					43.05	56.95	57.50	27.72	14.78	clay
	120-150	-					50.10	49.90	56.73	35.74	7.53	clay
mean		1.41					46.94	53.07	53.52	32.09	14.40	
2	0-30	1.30	0.41	0.52	0.56	0.50	63.52	36.48	54.30	32.43	13.27	clay
	30-60	1.34					50.46	49.54	55.44	30.00	14.56	clay
	60-90	1.39					49.85	50.15	56.68	29.66	13.66	clay
	90-120	1.43					57.49	42.51	51.21	33.77	15.02	clay
	120-150	-					55.32	44.68	63.42	23.92	12.66	clay
mean		1.36					55.33	44.67	56.21	29.96	13.83	
3	0-30	1.32	0.05	0.24	0.38	0.22	56.02	43.98	53.30	34.28	12.42	clay
	30-60	1.36					44.19	55.81	63.04	27.01	9.95	clay
	60-90	1.38					57.31	42.69	60.40	33.01	6.59	clay
	90-120	1.40					42.34	57.66	52.52	38.54	8.94	clay
	120-150	-					39.30	60.70	66.90	27.80	5.30	clay
mean		1.37					47.83	52.17	59.23	32.13	8.64	
4	0-30	1.39	0.24	0.27	0.33	0.28	53.50	46.50	50.96	24.84	24.20	Clay
	30-60	1.40					47.50	52.50	47.50	23.70	28.80	Clay loam
	60-90	1.48					62.40	37.60	43.44	18.35	38.21	Clay loam
	90-120	1.50					66.90	33.10	44.15	15.40	40.45	Clay loam
	120-150	1.51					65.80	34.20	35.00	14.60	50.40	Sandy clay loam
mean		1.46					59.22	40.78	44.21	19.38	36.41	
5	0-30	1.36	0.20	0.25	0.31	0.26	45.20	54.80	58.80	23.35	17.85	Clay
	30-60	1.42					34.20	65.80	67.17	22.62	10.21	Clay
	60-90	1.44					44.88	55.12	60.60	27.11	12.29	Clay
	90-120	1.47					56.90	43.10	50.54	24.64	24.82	Clay
	120-150	1.48					56.10	43.90	50.90	24.54	24.56	Clay
mean		1.42					47.46	52.54	57.60	24.45	17.95	
6	0-30	1.65	1.15	1.05	1.10	1.10	92.85	7.15	6.42	1.98	91.60	Sandy
	30-60	1.66					94.20	5.80	6.26	0.94	92.80	Sandy
	60-90	1.68					94.40	5.60	5.10	1.72	93.18	Sandy
	90-120	1.70					95.05	4.95	5.12	0.73	94.15	Sandy
	120-150	-					94.90	5.10	5.86	2.50	91.64	Sandy
mean		1.67					94.28	5.72	5.75	1.57	92.67	

Also, data in Table (4) illustrate that $CaCO_3$ content ranged from 2.9% to3.9% in profiles 2 and 3 respectively since was decreased in water table affected deep layers than surface layers (Nageeb, 1995) also, the mean values of CEC ranged between 37.51meq/100.g soil to 40.13 meq/100 g soil in profiles 3 and 1 respectively. It could be said that low variation between the mean values of CEC. Also data showed that CEC values of soils under high water table were higher than soils that had shallow water table and decreased towards Burullus lake with increasing salinity of irrigation water. The salinity of irrigation water may affect the activities of microorganisms responsible for decomposition of organic matter. These results are in agreement with (EL-Toukhy, 2004). The organic matter is relatively low in the most studied areas due to the prevailing of arid conditions, data showed that the mean values of organic matter ranged between 1.30 % to 1.12 % in profiles 1 and 3, respectively. The highest value was recorded in profile (1) in spite of fluctuation of water table due to cropping pattern and frequency of organic matter additions by the local farmers. The lowest value was observed in profile (3) since it decreased with increasing salinity and reusing of drainage water in irrigation purpose (EL-Toukhy, 2004).

Data in Table (4) revealed, wide variations in the available macronutrients content in the studied profiles in the surface layers, where it ranged from 20.48 ppm to 30.28 ppm for nitrogen (profiles No. 1 and No. 3), from 14.38 ppm to 20.42 ppm for P in profiles No.1 and No. 3 and from 395 ppm to 1065.6 ppm K in for profiles No. 1 and No.3. The remarkable increase of available macro nutrients values were found towards the Burullus lake due to the increase of salinity level.

The residual nutrient contents of nitrogen, potassium and phosphorus increased as salinity levels increased indicating the reduced ability of groundnut to uptake nutrients under high saline conditions.

Also the available macronutrients increased in the soil samples taken from profile No.3 after *Zea mays* crop. This increase may be due to the addition of inorganic macronutrients. In addition, it decreased in profile No. 1 as a result of the fluctuation of water table. This could be attributed to higher efficiency of leaching process under shallow water table compared to deeper water table.

EL-Gharbia main Drain:

It is considered one of the most important drains in north Delta.It collects not only the agriculture drainage water, but also sewage and industrial waste waters from EL-Gharbia and Kafr EL-Sheikh Governorates. Fluctuation of water table level in the soils located on EL-Gharbia main Drain was constant approximately and low variation. Data in Table 2 showed that the mean values of K hydraulic conductivity ranged between 0.26 to 1.10 m/day in profiles 5 and 6 respectively. The lowest value of hydraulic conductivity was recorded in profile No.5 due to soil salinization and the secondary process to alkalinization, which clay fraction charged more with sodium ions which disperse fine particles causing the soils desirable crumb structure to collapse, and its aggregates to slake down and clog soil pores creating impermeable condition. The highest value was recorded in profile No.6 due to sandy soil.

Data in Table (2) revealed that, the mean values of soil bulk density ranged between 1.36 to 1.67 g/cm3. It is noticed that the bulk density values increased with depth in subsurface layers with deeper water table and influence of organic matter residues (Nageeb, 1995).

Table (3): Aggregate stability of the studied profiles.

Profile No.	Depth, cm.	Aggregate size distribution of water stable aggregates%				Total WSA% >0.25	Total WSA% <0.25	MWD mm	AI*	SC**	Optimum size of aggregates (2-0.5 mm)
		>2 mm	2-1 mm	1-0.5 mm	0.5-0.25 mm						
1	0-30	2.510	12.740	8.200	3.270	26.720	73.280	0.393	0.197	0.365	20.940
	30-60	3.270	8.100	8.200	3.500	23.070	76.930	0.359	0.180	0.300	16.300
	60-90	3.140	6.100	6.500	3.500	19.040	80.960	0.309	0.155	0.235	12.600
	90-120	3.080	3.900	6.040	4.000	17.020	82.980	0.272	0.136	0.205	9.940
	120-150	1.300	2.600	6.160	4.300	14.360	85.640	0.166	0.083	0.168	8.760
Mean		2.660	6.688	7.020	3.714	20.042	79.958	0.300	0.150	0.254	13.708
2	0-30	5.500	7.680	10.000	5.350	28.530	71.470	0.485	0.243	0.399	17.680
	30-60	0.950	15.000	10.550	2.950	29.450	70.550	0.362	0.181	0.417	25.550
	60-90	1.980	2.270	7.200	5.200	16.650	83.350	0.206	0.103	0.200	9.470
	90-120	5.500	3.500	8.750	4.150	21.900	78.100	0.408	0.204	0.280	12.250
	120-150	5.000	1.350	5.550	3.460	15.360	84.640	0.324	0.162	0.181	6.900
Mean		3.786	5.960	8.410	4.222	22.378	77.622	0.357	0.179	0.296	14.370
3	0-30	8.100	3.900	9.950	6.250	28.200	71.800	0.562	0.281	0.393	13.850
	30-60	0.850	3.250	10.750	7.400	22.250	77.750	0.199	0.100	0.286	14.000
	60-90	3.030	1.300	9.080	7.200	20.610	79.390	0.266	0.133	0.260	10.380
	90-120	7.280	1.440	4.900	4.150	17.770	82.230	0.437	0.219	0.216	6.340
	120-150	2.350	0.850	3.420	3.250	9.870	90.130	0.168	0.084	0.110	4.270
Mean		4.322	2.148	7.62	5.650	19.740	80.260	0.326	0.163	0.253	9.768
4	0-30	0.150	3.450	8.500	5.500	17.600	82.400	0.143	0.072	0.214	11.950
	30-60	10.700	4.100	3.900	3.330	22.030	77.970	0.638	0.319	0.283	8.000
	60-90	0.150	2.650	1.760	5.650	10.210	89.790	0.081	0.041	0.114	4.410
	90-120	0.315	0.280	3.950	1.350	5.900	94.100	0.055	0.028	0.063	4.230
	120-150	4.600	2.400	0.710	0.560	8.270	91.730	0.273	0.137	0.090	3.110
Mean		3.183	2.576	3.764	3.278	12.802	87.198	0.238	0.119	0.153	6.340
5	0-30	0.480	0.660	2.950	2.600	6.700	93.300	0.044	0.022	0.072	3.610
	30-60	0.280	1.150	2.950	3.800	8.180	91.820	0.067	0.034	0.089	4.100
	60-90	0.180	0.500	2.500	4.400	7.600	92.400	0.051	0.026	0.082	3.000
	90-120	0.120	0.200	0.400	1.150	1.870	98.130	0.016	0.008	0.019	0.600
	120-150	0.100	0.150	0.740	2.100	3.200	96.800	0.020	0.010	0.033	0.890
Mean		0.232	0.532	1.908	2.810	5.510	94.490	0.040	0.020	0.059	2.440

AI= Aggregation index **SC** = Structure coefficient**

Regarding the particle size distribution, the water table is greatly affected by clay sorting especially fine clay fraction (<1µ) through soil profile. This phenomenon which called clay migration is clear in profiles with high water table depth and moderate and high clay content, it leads in some profiles to encourage the formation of argillic and Natric horizon when the water table contains a high value of sodium, with high ESP values. Such results in agreement with, Nageeb (1995).

Aggregation parameters decreased in profiles 4 and 5 due to the reusing of drainage water for irrigation purpose in EL-Gharbia main drain which led to increase of exchangeable Na+ and ESP. On the other hand, exchangeable Ca^{2+} decreased.

The soil chemical properties of the studied soil profiles are presented in Table (4). The mean values of EC along the line under consideration ranged between 8 to 20.26 dS m^{-1} in profiles 5 and 4 respectively, the highest value was recorded in profile 5 due to the effect of the sea water as a source of salts, which contaminates water table zone and irrigation with ELGharbia main drain.

Table (4): Some soil chemical properties of the investigated soil profiles

Profile No.	Depth, cm	pH	EC, dS m^{-1}	SAR	$CaCO_3$ %	ESP, %	CEC, meq/ 100 g.soil	OM %	Macronutrients (ppm)		
									N	P	K
1	0-30	8.40	4.25	5.63	3.75	14.00	44.10	1.85	16.40	9.00	296.0
	30-60	8.32	4.90	9.23	3.17	23.00	38.10	1.77	23.70	12.75	289.0
	60-90	8.48	5.30	9.56	2.96	30.30	36.80	1.25	18.20	16.55	453.0
	90-120	8.55	5.80	9.67	3.17	33.30	36.80	0.85	23.60	19.22	542.0
	120-150	8.46	6.50	12.11	3.17	38.60	31.75	0.80	21.80	29.30	764.0
Mean		8.44	5.28	9.24	3.2	27.84	37.51	1.30	20.48	14.38	395.0
2	0-30	8.04	7.50	10.61	3.40	20.35	40.65	1.95	41.90	14.95	546.0
	30-60	8.39	6.00	6.72	3.17	20.30	41.90	1.60	10.90	18.15	333.0
	60-90	8.40	5.50	8.04	2.32	35.40	38.10	0.80	12.70	17.60	923.0
	90-120	8.43	5.20	11.08	3.40	36.00	39.40	0.77	29.10	16.80	393.0
	120-150	8.46	7.10	11.44	2.32	38.50	40.60	0.65	34.70	23.50	122.0
Mean		8.34	7.16	9.58	2.9	30.111	40.13	1.15	25.86	18.20	463.4
3	0-30	8.39	6.00	8.56	5.00	16.00	44.45	1.70	42.00	15.75	644.0
	30-60	8.51	7.90	11.18	4.45	23.50	40.65	1.45	40.20	19.45	704.0
	60-90	8.43	7.00	12.70	4.10	32.20	38.10	0.95	16.40	21.60	928.0
	90-120	8.29	14.00	15.51	3.10	45.50	33.00	0.80	20.00	16.30	1512.0
	120-150	8.48	13.50	14.50	3.20	44.00	34.30	0.70	32.80	29.00	1540.0
Mean		8.42	9.68	12.49	3.9	32.24	38.10	1.12	30.28	20.42	1065.6
4	0-30	7.38	15.70	13.34	0.65	12.20	52.00	1.70	58.30	18.15	570.0
	30-60	7.30	5.50	10.02	0.40	10.85	43.00	1.45	31.00	23.75	450.0
	60-90	7.17	7.00	9.55	1.50	17.75	36.80	0.95	29.10	20.25	560.0
	90-120	7.21	7.40	7.04	1.00	16.60	35.50	0.86	21.80	20.80	540.0
	120-150	7.33	7.30	7.73	1.20	16.60	38.00	0.85	16.40	22.20	560.0
Mean		7.28	8.00	9.54	0.9	14.80	41.06	1.16	31.32	21.03	536.0
5	0-30	7.70	15.60	15.10	2.50	34.70	44.40	0.94	32.70	22.50	950.0
	30-60	7.61	19.80	14.69	2.10	42.85	49.50	0.87	27.30	23.70	1150.0
	60-90	7.57	20.90	20.84	2.32	46.30	48.00	0.80	41.80	23.70	1100.0
	90-120	7.59	23.00	19.31	2.10	40.00	41.90	0.75	25.50	18.70	1150.0
	120-150	7.55	22.00	17.62	2.70	39.10	41.90	0.62	29.10	16.50	1170.0
Mean		7.60	20.26	17.51	2.3	40.59	45.14	0.80	31.28	21.02	1104
6	0-30	8.12	5.20	2.29	2.10	5.10	10.00	0.47	50.00	16.80	270.0
	30-60	8.45	7.00	7.25	1.70	10.00	7.60	0.19	32.70	14.90	180.0
	60-90	8.35	8.50	8.97	1.50	4.50	10.10	0.15	41.85	17.25	90.0
	90-120	8.26	10.00	5.46	2.10	4.85	10.50	0.20	29.10	17.25	70.0
	120-150	8.25	12.00	8.60	1.20	6.30	11.40	0.15	29.10	15.20	85.0
Mean		8.29	8.54	6.51	1.7	6.15	9.92	0.23	36.55	16.28	139.0

Data showed that the values of, SAR, ESP, soluble cations, and anions were increased in profiles 4 and 5 due to increasing groundwater salinity, concentration of sodium ions and traditional agricultural practices (El-Hamashary *et al.*1992), while these values decreased in profile 6 where the texture of soil was sandy soils.

Data in Table (4) revealed that, the mean values of pH ranged from 7.28 to 7.60 in profiles 4 and 5, respectively. The pH decreased with soil salinity and water table salinity. These results are in agreement with those obtained by EL-Shahway (2008). While in sandy soil the pH values were increased according to buffering effect for sandy soils (Noufal 2000).

The values of total calcium carbonate ranged between 0.9 to 2.3 % in profiles 4 and 5 respectively while it was 1.7 % in profile 6. Also, data showed that the values of $CaCO_3$ increased with the soil depth due to the presence of the shell fragments at deeper layers which characterize the lacustrine soils and the highest value was recorded in profile 5 due to reuse of drainage water in irrigation and high saline groundwater which gives a good conditions that help to solve $CaCO_3$.

Also, data in Table (4) illustrate that the mean values of CEC varied from 41.06 meq/100 g. soil to 45.14 meq/100 g soil in profiles 4 and 5 respectively, the highest value was recorded in profile 5. It could be ascribed to the variation in clay content and re-use of wastewater in irrigation purpose from Elgharbia main drain.

Regarding the mean values of organic matter, data showed that it ranged between 1.16 % in profile 4 and 0.23 % in profile 6, while it was 0.80 % in profile 5. Also the percentage of organic matter decreased in the sea direction according to soil salinity and soil texture. EL-Toukhy, (2004) reported that salinity of irrigation water may affect the activities of microorganisms responsible for decomposition of organic matter.

Data in Table (4) illustrate that the available nitrogen ranged from 31.32 ppm to36.55 ppm for profiles No.4 and No.6, from 16.28 ppm to 21.03 ppm for P in profiles No.6 and No.4 and from 139 ppm to 1104 ppm for K in profiles No.6 and No. 5, respectively. According to Hamissa *et al.*(1993) Egyptian soils are considered to be deficient in macronutrients, when the available contents are less than 40 ppm for nitrogen, 10 ppm for phosphorus and 200 ppm for potassium.

Omar *et al.* (2001) reported that irrigation with drainage water, increased the soil available NPK compared to fresh water after harvesting of sugar beet and canola. Such increase was probably due to the high content of these elements in drainage water than fresh water.

Regarding the effect of soil texture on soil macronutrients, data in Table (4) show that P, K in clay soils were higher than sandy soil. where the mean values of soil P and K for sandy soil profile No.6 were 16.28 ppm and 139 ppm respectively. While they were 21.03 ppm and 536 ppm in profile No.4.

Chemical analysis of water samples of groundwater, irrigation water and drainage water:

Chemical analysis of different types of water samples in two lines are presented in Table (5). The progressive increase in water table, irrigation and drainage water salinity near the sea and Burullus lake may be due to the salinity of sea water intrusion with irrigation canals and drains. In the first line, the highest values were found in El-Kawasem locations (Profile 3) and the lowest values were found in El-Ghanamen location (Profile 1). The lowest values were found in Kafr-Dokhmes location (Profile 4). Sodium adsorption (SAR) was calculated for irrigation, drainage and water table for two lines.

Values of SAR was very high in water table > drainage > irrigation. It can be concluded that the irrigation water in all locations can be used for irrigation without any hazard to sodium and alkalinity according to Ayers and Westcot (1985), but according to salinity effect, it could cause problems in the long run of application. Use of poor water quality in the irrigation processes may play a very bad role in the contamination and degradation of agriculture soils. Respecting the analysis of water samples, water quality in El-Gharbia main drain was less than water quality in Nashart drain. El-Gharbia main drain is considered one of the most important drains in north delta. It collected not only agriculture drainage water, but also sewage and industrial waste water from both El-Gharbia and Kafr El-Sheikh governorates. Using El-Gharbia main drain in agriculture purposes needs special practices and wise management such as effective drainage system and growing high tolerant crops, tea salinity.

Table (5): Chemical analysis of water samples (groundwater, irrigation water and drainage water).

Profile No.	EC, dS m^{-1}	SAR	Classes	Location samples
P1 groundwater	10.0	13.3	C4-S3	Nashart drain
P1 Irrigation water	1.0	1.6	C3-S1	
P1 drainage water	1.5	2.8	C3-S1	
P2 groundwater	6.8	10.2	C4-S2	
P2 Irrigation water	1.7	2.3	C3-S1	
P2 drainage water	1.8	3.3	C3-S1	
P3 groundwater	18.0	12.8	C4-S3	
P3 Irrigation water	1.8	3.5	C3-S1	
P3 drainage water	2.1	4.7	C3-S1	
P4 groundwater	4.3	18.8	C4-S4	El-Gharbia drain
P4 Irrigation water	1.2	5.6	C3-S1	
P4 drainage water	1.6	5.7	C3-S1	
P5 groundwater	3.9	18.4	C4-S4	
P5 Irrigation water	1.0	5.5	C3-S1	
P5 drainage water	1.4	5.7	C3-S1	
P6 groundwater	5.2	7.0	C4-S2	
P6 Irrigation water	2.5	5.8	C4-S2	
P6 drainage water	4.2	6.8	C4-S2	

Effect of water table fluctuation in tail of irrigation canals and drains on water table level :

Water table depth plays an important role in features of soil. It greatly varies in profile 1 in the first line. These variations depend mainly on the local conditions activity, such as seepage from irrigation canals or drains when gates are blocked and seepage from high land to neighbour low lands. Low variation of water table depth in the second line due to the control of water table by EL-Gharbia main drain.

Clear variations are recorded in EL-Ghanamen location. The water table depth, in general, ranges between 0 cm and 86 cm and seepage comes from Nashart drain to in EL-Balasy since it ranged between 37 cm and 75 cm, while ranged in EL-Kawasem between 41 cm. and 76 cm. On the other hand in the second line. In Kafr-Dokhmes water table depth ranged between 85 cm and 110 cm, also in village 7, it ranged between 32 cm and 135 cm, while in Hamad ranged between 60 cm and 105 cm.due to the control of water table by EL-Gharbia main drain.

Table (6): annual values of water table level (cm) in the studied areas.

	The first line			***The second line***		
	EL-Ghanamen	***EL-Balasy***	***EL-Kawasem***	***Kafr-Dokhmes***	***Village 7***	***Hamad***
WTL	52.09	60.35	57.75	97.5	92.06	80.11

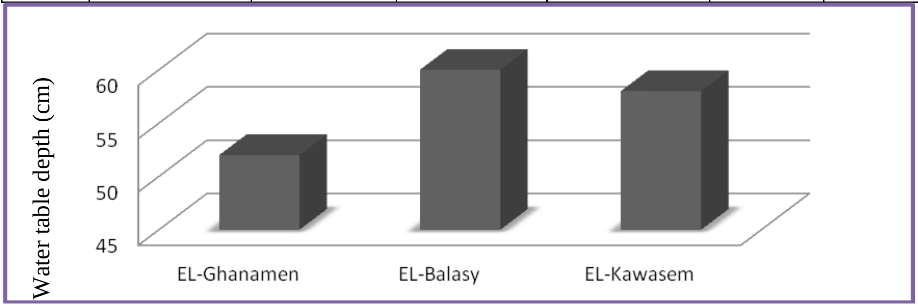

Fig. 1: Annual water table level in the first line (cm)

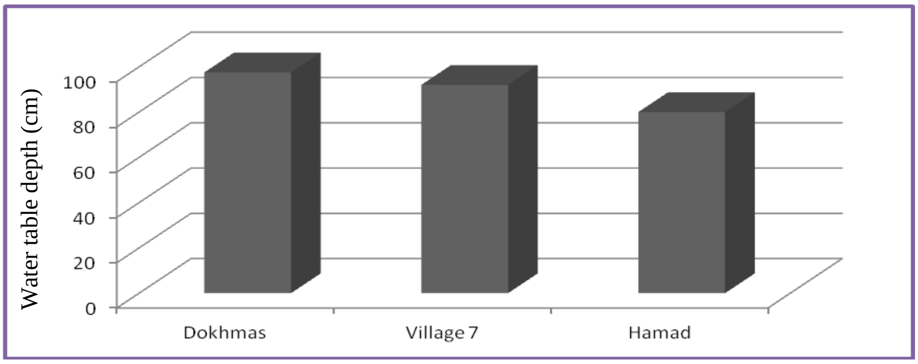

Fig. 2: Annual water table level in the second line (cm)

Water table depth in the second line was lower than that recorded in the first line. The highest water table depth in the first line due to seepage from Burullus lake and gates blocking on Nashart drain. While the deepest water table in the second line may refer to surface drainage in EL-Gharbia main drain which control the water table and remove it from the root zone. It is observed from the data that the water table level raised up near soil surface in soil profiles adjacent to the Burullus lake and the sea. These findings may be attributed to the high effect of water seepage from the lake. (EL-Hamshary, 1980).

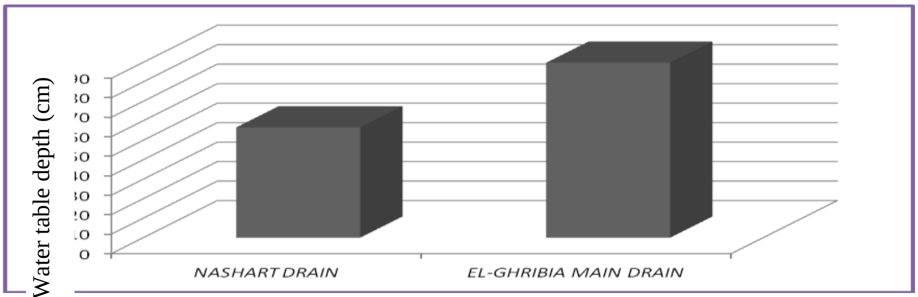

Fig. 3: Annual water table level in two lines

CONCLUSION

It could be concluded that the hazard impact of drainage water on the plant growth is due to the deterioration of both physical and chemical properties of soil irrigated by EL-Gharbia main drain. The irrigation with fresh water, can reduce water table from root zone of crops, is the best practice and conserves such salt affected soils in northern part of the Nile Delta. Gypsum and superphosphate are recommended to be added to the soils to decrease their sodicity and improve their permeability to accelerate the rate of leaching salts. Also it could be concluded that the fluctuation of water table must be controlled by installation of tile drainage and raised the efficiency of drainage system under such conditions.

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أثر تذبذب مستوي الماء الارضى بنهايات الترع والمصارف علي خواص التربة الطبيعية والكيميائية فى منطقة شمال دلتا النيل

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أجريت هذه الدراسة بهدف دراسة تأثير تذبذب مستوي الماء الارضى بنهايات الترع والمصارف علي بعض خواص التربه وعمق الماء الارضي بشمال دلتا النيل.لذلك اخذت ٦ قطاعات ارضيه مثلت محافظة كفر الشيخ مع اختيار خطين يمتد الخط الاول من بحيره البرلس شمالا حتي مدينه سيدي سالم جنوبا ويمتد الخط الثاني من البحر الابيض المتوسط شمالا حتي مدينه كفر الشيخ جنوبا والخط الاول طوله ٢٠ كم وتم اختيار ٣نقاط عليه بمسافات تبعد عن البحيره ٥-١٠-٢٠ كم علي امتداد مصرف نشرت اما الخط الثاني طوله ٣٠ كم وتم اختيار ايضا ٣ نقاط عليه بمسافات ٥-٢٠-٣٠ كم علي امتداد مصرف الغربية الرئيسي.

وتم تركيب أبار رصد على أبعاد ١٠ ، ٥٠ ، ١٠٠ متر من المصرف لقياس عمق مستوى الماء الأرضى من سطح الارض وتجميع عينات منها لتحليلها. واوضحت النتائج ان قيم التوصيل الهيدروليكي زادت مع زيادة عمق الماء الأرضى بالنسبة لسطح الارض وأوضحت النتائج أيضا تناقص قيم التوصيل الهيدروليكى كلما إتجهنا نحو البحر الابيض المتوسط وأيضا زيادة قيم التوصيل الهيدروليكى كلما بعدنا عن المصارف العمومية. ايضا قيم الكثافه الظاهريه زادت مع العمق. واشارت النتائج الي زيادة الطين الأقل من ١ ميكرون في الطبقات التحت سطحيه ٣٠-٩٠ سم وخاصة في القطاعات المتاثره بالماء الارضي ومحتوي الطين العالي بينما قلت التجمعات الارضيه في حالتي القطاعات ذات مستوي ماء أرضي ضحل و العاليه الملوحه.

توضح النتائج أيضا أن الخواص الكيميائيه زادت في إتجاه بحيره البرلس عدا الماده العضويه والسعه التبادليه الكاتيونيه وقلت أيضا في القطاعات ذات مستوي ماء ارضي ضحل بالمقارنة بمستوي الماء الارضي البعيد عن سطح التربة. وأشارت النتائج الي زياده محتوي التربه من العناصر الكبري الميسره مع إستخدام مياه الصرف الزراعى في اغراض الرى. وعموما يمكن التوصية بالتحكم فى تذبذب مستوى الماء الأرضى من خلال رفع كفاءة شبكة الصرف تحت هذه الظروف، وكذلك توفير مصدر مياه رى وذلك لتقليل فترات سد البوابات.

قام بتحكيم البحث

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