SIGNIFICANCE OF APPLIED ORGANIC MANURE FOR MINIMIZING HAZARDOUS EFFECTS OF WATER SALINITY AND SPECIFIC ANIONS ON SOME CHARACTERISTICS OF A CALCAREOUS SOIL AND PLANTS GROWN THEREON

Abdel Nasser A.A. Abdel Hafeez
Soils and Water Dept., Fac. of Agric., Fayoum University, Egypt.

ABSTRACT:

A green house pot experiment was carried out on a newly reclaimed calcareous sandy loam soil (0-30 cm) having about 22 % $CaCO_3$ at Demo Experimental Farm of Agric. Fac., El Fayoum Univ. to study the hazardous effects of the usage of different water salinity levels (i.e., 250, 600, 1200, 2400 and 4800 mg L^{-1}) as well as the specific effect of anions (i.e., Cl^-, CO_3^{2-} and SO_4^{2-}) on some soil and plant characteristics. The response of the studied soil and the plants grown thereon (elephant grass as a new summer green forage) characteristics to organic manure (organic compost of plant residues) was a matter of concern in this study.

The obtained results showed that there were pronounced adverse effects on the studied soil physio-chemical properties as well as its fertility status (i.e., bulk density, soil strength, total porosity, hydraulic conductivity, available water content, pore size distribution, organic matter content, pH, ESP and the released available nutrients content in soil) with increasing water salinity levels. In addition, these negative effects were not only associated with rising water salinity levels but also with the specific effect of anions. However, the hazardous effect of Na_2CO_3 salt surpassed both NaCl and Na_2SO_4 levels due to its destroyer effect on soil aggregates, and consequently the other studied soil properties. In this concern, the accompanied anions could be categorized according their hazardous effects in an ascending order: $CO_3^{2-} > Cl^- > SO_4^{2-}$.

The aforementioned hazardous effects of the applied water salinity levels on soil characteristics were extended to the vegetative growth (germination percentage and dry weight) and the nutrients uptake by the grown elephant grass plants, which showed gradual decreases with increasing water salinity levels. This may be attributed to the adverse effect of the higher soil solution salinity on inhibiting uptake of plant roots for all nutrients. It was also evident from the obtained data that applied organic compost at a rate 30 m^3/fed led to alleviate many of the adverse effects of the water salinity levels and their specific effects on both the studied soil and plant characteristics. In general, the applied organic manure increased active organic acids, and hence enhanced the availability of both essential macro- and micronutrients (N, P, K, Fe, Mn, Zn and Cu). The later case is considered more affective under restrictive conditions of such calcareous soil media; moreover the applied organic manure attained a relatively higher content of these essential nutrients.

Key words: Calcareous soil, organic manure, elephant plants, water salinity and specific effect of anions.

INTRODUCTION:

The majority of promising areas for agricultural utilization in Fayoum depression under arid and semi arid climate are calcareous in nature, having poor hydrophysical and fertility status. At the same time, Fayoum region is suffering from a shortage in fresh Nile irrigation water and because it is an enclosed depression with internal drainage condition, a balance should be kept between irrigation and drainage water. Since few years, the use of saline water (i.e., a mixture of the Nile water and drainage one with a ratio of 1:1) in agricultural purposes was carried out to cover the shortage of water needed for either the cultivated soils particularly in summer season or for the newly reclaimed ones. Also, in the last few years, there is a pronounced change in the cropping pattern; due to entering an elephant grass as green forage at the summer season. Therefore, one of the most additional developments is controlling the positive interaction between soil properties as affected by water quality and yielding plant varieties under different conditions of water use efficiencies **(Abdel Razek, 1998).**

Improper low quality water use and soil management not only detract from attainment of potentials, but also cause productive land to be withdrawn from cultivation through forming surface salt or lime crust, waterlogging and increasing salinity and sodicity. Crop production using saline waters depends upon the tolerance of the crop, soil management and agro-climatic conditions. However, the use of saline water in irrigation causes negative effects on many of soil properties, i.e., pH and ion exchange equilibrium and salt concentrations **(Wilcox and Durrum, 1967). Bayoumi** ***et al.*** **(1997)** mentioned that some nutrient concentrations and uptake by barley decrease with increasing salinity level than 600 mg/L in irrigation water. **El Tapey and Hassan (2002)** found a specific effect for SO_4^{2-} on decreasing soil pH, enhancing the availability of Zn and consequently its uptake by plants under salinity stress. **Abdel Aziz (2004)** mentioned that the greater levels of salts in irrigation water than 5.58 dS/m significantly decreased the dry matter yield of barley plants. **El Tapey** ***et al.*** **(2005)** found that vegetative growth parameters, yield and its components showed gradual significant decreases with increasing salinity levels in irrigation water. They added that N, P, K, Fe, Mn, Zn and Cu contents in biological yield of barley were decreased with the progressive levels of salts in irrigation water used. These parameters can be improved by applying some soil amendments such as sulfur and farmyard manure.

The addition of organic manure is of vital importance to improve physical characteristics of the soils, where it reduces soil bulk density and increases soil porosity **(Hussien & Abdel-Aziz, 1992; and Logan** ***et al.*****, 1996). In addition, Abdel-Aziz** ***et al.*** **(1996)** stated that farmyard manure increased the hydraulic conductivity of soil. **Hassanien (1996)** found that addition of farmyard manure at a rate of 2% caused a sharp decrease in soil strength of the topsoil of calcareous soil, where its value decreased from 3.90 to 0.75 bar. Soil pH value was modified by compost amendment **(Tester, 1990). Abdel-Aziz** ***et al.*** **(1996)** reported that increasing rate of farmyard manure applied to calcareous soil, generally, decreased soil pH. **Tsadilas** ***et al.*** **(1995)** found that the application of sewage sludge to soil significantly increased organic matter content. The positive effect of organic materials on the yield was shown by many authors; **Hussien** ***et al.*** **(1998)** with wheat, **Abdel-Aziz** ***et al.*** **(1996) with sunflower and Abdel-Aziz** ***et al.*** **(2000) and Basyouny (2002)** with ryegrass, **Wahdan** ***et al.*** **(2005)** with barely; found successive increase in the yields with increasing the levels of the applied farmyard manure to soil.

This study was an attempt to assess the adverse effects of different irrigation water salinity levels and specific anion effect on both soil and grown elephant grass characteristics. Also, the curing effect of applied organic manure on both soil and plant grown thereon was a matter of concern in this study.

MATERIALS AND METHODS:

A green house pot experiment was carried out on a newly reclaimed calcareous sandy loam soil (0-30 cm) having about 22 % $CaCO_3$ at Demo Experimental Farm of Agric. Fac., Fayoum Univ. to study the hazardous effects of the usage of different water salinity levels (i.e., 250, 600, 1200, 2400 and 4800 mg L^{-1}) as well as the specific effect of anions (i.e., Cl^-, CO_3^{--} and SO_4^{--}) on some soil and plant characteristics. The response of the studied soil and the grown plants (elephant grass as a new summer green forage) characteristics to organic manure (organic compost of plant residues) was a matter of concern in this study. Each salinity level was prepared from NaCl, Na_2CO_3 and Na_2SO_4 salts. The experimental soil was analyzed for physical, chemical and fertility properties according to **Jackson (1973) and Page *et al.* (1982),** and results of analysis are shown in Table (1).

Table (1): Some characteristics of the studied soil.

Soil characteristics	Values	Soil characteristics	Values
Particle size distribution %:		*Soil chemical properties:*	
Coarse sand	34.72	pH (1: 2.5 ,soil suspension)	8.15
Fine sand	41.19	Organic matter %	0.36
Silt	8.95	ESP	8.42
Clay	15.14	ECe, dS/m (soil paste extract)	3.94
Textural class*	SL	*Soluble cations (m molc L^{-1})*	
Total calcium carbonate %	22.37	Ca^{2+}	12.05
$CaCO_3$ distribution in mechanical fractions:		Mg^{2+}	7.95
Sand	1.55	Na^+	18.53
Silt	4.47	K^+	0.45
Clay	16.35	*Soluble anions (m molc L^{-1})*	
Soil physical properties:		CO_3^{2-}	0.00
Soil strength (kg/m^2)	2.96	HCO_3^-	2.85
Bulk density (g/cm^3)	1.32	Cl^-	21.40
Total porosity %:	44.65	SO_4^{2-}	14.73
Hydraulic conductivity (cm/h)	9.78	*Available nutrients (mg kg^{-1} soil):*	
Available water %	12.47	N	26.78
Pore size distribution %:		P	5.43
Quickly drainable pores	8.02	K	143.51
Slowly drainable pores	10.51	Fe	5.82
Water holding pores	12.47	Mn	1.64
Fine capillary pores	13.65	Zn	1.05
Useful pores	22.98	Cu	0.92

SL=sandy loam

Plastic pots of 45 cm diameter and 35 cm height, with bottom gravel layers and holes to remove the excess of irrigation water, were used. One half of the experimental pots was treated with the organic manure (organic compost of plant residues) at the recommended rate (30 m^3/fed) undertaken by **Wahdan *et al.* (2006)** for such studied soil. Thus, the treatments of organic manure included two rates (i.e., 0 and 30 m^3/fed), which thoroughly mixed with soil in half of the experimental pots, in combination with the used twelve irrigation water resources (3 salt types x 4 water salinity levels), and three replicates. This means that total treatments under investigation reached [(2 organic manure rates x 12 saline water solutions) + (2 organic rates x 1 control)] x 3 replicate = 78 pots. The main characteristics of the applied organic compost are given in Table (2). Eight kg portions of air-dried soil were weighed in each pot, well mixed and uniformly packed in pots at the initial soil bulk density value of 1.32 g/cm^3.

Table (2): Some chemical characteristics of the used organic compost.

Characteristics	Value
Weight of 1 m^3 (kg)	397.35
pH (1:10 water suspension)	7.21
EC (dS/m, 1:10 water extract)	0.97
Moisture content %	9.02
Organic matter %	42.75
Organic carbon %	24.85
C/N ratio	14.70
Total macronutrients %:	
N	1.69
P	0.39
K	2.37
Total micronutrients (mg/kg):	
Fe	81.02
Mn	34.46
Zn	27.15
Cu	16.37

Thirty elephant grass seeds were planted at the first week of May 2006 and irrigated with the different water salinity levels using intervals flooding system every ten days. Ten days later the seedlings were thinned to fifteen healthy seedlings. The experiment was laid out with twenty six treatments of the previous irrigation water salinity levels and organic manure, with three replicates, and arranged in a complete randomized block design. The grown plants were fertilized with ammonium nitrate (33.5 % N) at a rate of 120 kg N/fed added in two equal doses (during preparing the soil and 45 days from planting). Superphosphate (15 % P_2O_5) at a rate of 150 kg/fed was added before planting. Potassium sulfate (48 % K_2O) at a rate of 100 kg/fed was added in two equal doses at the same periods of N application. Elephant grass plants were harvested after 45 and 90 days to represent the first and second cuts, respectively.

Soil sampling was carried out immediately after harvesting, air dried, crushed, sieved to pass through a 2 mm sieve and analyzed for determining the chemical and fertility properties. Undisturbed soil samples were analyzed for bulk density **(Black and Hartge, 1986)**, hydraulic conductivity, total porosity **(Black *et al.*, 1965)**. Soil strength and penetrability were estimated using the Penetrometer (EISELKAMP–Giesbeek, Equipment, Netherland, Model 2-81-154-2), which was described by **Klute (1986)**. Soil moisture content at different tensions as well as the equivalent pore diameters and available water range **(Klute, 1986)**, organic matter content (Walkely and Black method as described by **Hesse, 1971)**, $CaCO_3$ content **(Wright, 1939)**, cation exchange capacity, exchangeable sodium percent, pH and soil paste extract were determined **(Jackson, 1973)**. Available N, P and K in soil were extracted by 1 % potassium sulphate, 0.5 M sodium bicarbonate and 1 N ammonium acetate, respectively, and their contents in soil were determined according to **Jackson (1973)**. Available micronutrients of Fe, Mn, Zn, and Cu in soil were extracted using ammonium bicarbonate-DTPA extract according to Soltanpour and **Schwab (1977)**, and their contents in soil were measured by using the Atomic Absorption Spectrophotometer.

As for plant determinations, the germination percentage was calculated at the early stage of the experiment; the vegetative growth was determined as dry weight per pot at harvest stage of each cut. At harvest, plant samples were collected and dried at 70 C^{o}, ground in a Willy mill and digested with H_2SO_4 and H_2O_2 according to **Parkinson and Allen (1975)** to determine N, P, K **(Chapman and Pratt, 1961)**, Fe, Mn, Zn and Cu **(Hesse, 1971)**. The obtained data of plant parameters were statistically analyzed according to the methods suggested by **Gomez and Gomez (1984)**, using the L.S.D. at 0.05.

RESULTS AND DISCUSSION:

Saline water application as an irrigation source does not only negatively affect soil properties, but also virtually all the parameters of the plants grown thereon. From this point of view, this study was carried out to clarify the hazardous effects of water salinity levels (600-4800 mg L^{-1}) and specific effect of accompanied anions on the studied characteristics of both soil and plant as compared to those irrigated with the fresh Nile water (250 mg L^{-1}).

I. Soil properties as affected by saline water as a source for irrigation:

a. Soil hydrophysical properties:

The obtained data in Table (3) indicate that usage of saline water as a source for irrigation left its hazardous footprints on the different hydrophysical properties of the studied soil, however, the changes in soil properties depended on water salinity levels under investigation. The values of soil strength and bulk density gradually increased with increasing the applied water salinity levels. As for soil strength, it may be rendered to the secondary lime accumulation (active $CaCO_3$) under wet condition of irrigation saline water and the hot climatic conditions, whereas, the trend of soil bulk density could be attributed to the negative effects of applied Na-salts on dispersion of soil aggregates. These findings are in agreement with those obtained by **Batey (1990)** who reported that soil bulk density was closely related to solid phase properties and pore space, which depend upon the changes in soil texture and other factors, i.e., soil salinity and alkalinity. It is noteworthy to indicate that the rate of soil bulk density change was not only dependent upon applied water salinity levels, but also on the dissolved salt types. The hazardous effect of applied Na_2CO_3 solutions was generally greater than those of either NaCl or Na_2SO_4 ones, reflecting the specific effect of the accompanied anion of CO_3^{2-} **(Van de Graaff and Patterson, 2001)**.

However, it can be deduced that the higher the water salinity levels the lower total porosity percentages under investigation. This trend could be attributed to the relatively higher ESP value, which tended to be more than 30% in the treated soil, as shown in Table (2). On the contrary, a pronounced decrease in soil available water range was observed with increasing the applied water salinity level as compared to soil treaded with the Nile fresh water. This could be explained on the basis that increasing soil salinity did not only decreased soil moisture content at field capacity, but also increased moisture content at wilting point at the same time, and in turn this coupled relationship resulted in decreasing the available water range. The relatively high soil moisture retained at wilting point may be ascribed to the effect of osmotic potential on increasing the ability of the treated soils with saline water to retain more moisture content **(Basyouny, 2002)**.

Soil permeability (hydraulic conductivity) depends on many factors, especially the volume of drainable pores. The previous data indicated that applying saline irrigation water led to decrease total porosity of soil, which is associated with depressing the volume of drainable pores, due to the degradation of soil aggregates and the dispersion of soil particles created by ESP value. Thus, the values of hydraulic conductivity tended to decrease with increasing the levels of applied saline water. With respect to pore size distribution as related to water salinity levels, data in Table (3) revealed that the percentages of drainable, water holding and useful pores tended to decrease with increasing the salinity levels of the applied irrigation water. This trend could be attributed to the degradation effect of Na-salts, particularly Na_2CO_3, on soil aggregates at the relatively high ESP value, which tended to be more than 30% in the treated soil, as shown in Table (2).

Role of applied organic manure for alleviating the hazardous effects:

Data presented in Table (3) also showed that the application of soil organic manure for the studied soil resulted in improving the soil strength and bulk density values, since their values tended to decrease at all of applied levels of the saline water used. This trend could be attributed to the positive effect of the released active organic acids on alleviating soil hardness of lime crust underlain compacted condition that were resulted from the secondary lime accumulations (active $CaCO_3$) resulting from the carbonation process under wet condition of irrigation water and the hot climatic conditions. These results are supported by the conclusions of **El Tapey *et al.* (2005)** for the beneficial effect of organic manure on the reduction of soil compaction. This hold was true, since the released active organic acids have been found to cause a profound effect on not only the biological activity, but also on soil structure **(El Fakharani, 1999)**. With respect to the effect of applied organic manure to the studied soil on the total soil porosity, data in Table (3) showed that applied organic manure plays a dual positive role, i.e., reducing soil bulk density vs increasing total soil porosity. These results are in harmony with those reported by **Laila Hussien *et al.*. (1998)** for the effect of farmyard manure.

Results presented in Table (3) also showed that the applied organic manure affected differently the hydraulic conductivity values of the studied soil, where gradual decreases in the hydraulic conductivity values were occurred. The improvement of hydraulic conductivity in such calcareous soil may be attributed to the positive effects of released active organic acids and Ca^{2+}, which enhance aggregation condition " size and stability of soil aggregates" **(Abdel Aziz *et al.*, 1996)**. Such condition also encouraged the creation of micro pores between and inside the compound packing particles **(Hussien *et al.*, 1998)**. Concerning the beneficial effect of applied organic manure on soil available water range, it was found that the soil treated with organic source possesses field capacity values surpassed those of wilting point, due to the beneficial role of organic manure on modifying soil structure. This is mainly due to soil field capacity is more dependent upon soil structure, while wilting point is more affected by soil texture. In addition, organic compounds have high ability to retain a pronounced content of water. These results are emphasized by **Cheng *et al.* (1998)** who reported that active organic acids decreased the loss of soil moisture, and in turn enhanced the water retention. Moreover, the beneficial effects of organic manure were extended to pore size distribution, since and the water holding and useful pores tended to increase with applying the recommended rate of organic compost. This could be attributed to the positive effect of the released active organic acids on soil aggregation. These findings are confirmed by **Askar *et al.* (1994)** who found that the addition of organic materials to calcareous soil greatly increased the water holding pores and decreased the area between the boundary lines (drying and wetting curve) of the hysteresis loops.

Table (3): Effect of water salinity levels and specific effect of anions on the hydrophysical properties of the studied soil.

Soil characteristics	Water salinity levels (mg L^{-1})									
	250		600		1200		2400		4800	
	Organic manure (m^3/fed)									
	0	30	0	30	0	30	0	30	0	30
NaCl										
Soil strength (kg/m^2)	3.04	2.39	3.21	2.63	3.27	2.75	3.32	2.83	3.37	2.95
Bulk density (g/cm^3)	1.30	1.26	1.32	1.30	1.35	1.32	1.37	1.34	1.39	1.35
Total porosity %:	45.35	49.93	43.42	46.80	42.53	44.81	39.90	42.01	38.36	40.45
Hydr. Cond. (cm/h)	9.21	7.84	9.02	7.69	8.61	7.23	8.24	6.95	7.96	6.42
Available water %	12.64	15.12	11.24	12.56	11.45	12.70	11.69	12.87	10.90	11.74
Quickly drainable pores	9.33	7.35	7.95	8.71	6.57	8.30	5.92	6.90	4.92	5.62
Slowly drainable pores	10.12	9.81	9.93	10.86	7.86	9.46	7.85	8.98	6.76	7.59
Water holding pores	12.64	15.12	11.24	12.56	11.45	12.70	11.69	12.87	10.90	11.74
Fine capillary pores	13.26	17.65	14.30	14.67	16.65	14.35	14.44	13.26	15.78	15.50
Useful pores	22.76	24.93	21.17	19.31	22.16	19.54	21.85	17.66	19.33	23.42
Na_2CO_3										
Soil strength (kg/m^2)	3.04	2.39	3.29	2.75	3.35	2.87	3.41	2.95	3.49	3.17
Bulk density (g/cm^3)	1.30	1.26	1.34	1.32	1.37	1.34	1.39	1.37	1.42	1.40
Total porosity %:	45.35	49.93	42.51	44.68	40.82	41.91	37.64	38.65	36.70	37.69
Hydr. Cond. (cm/h)	9.21	7.84	8.70	7.02	8.42	6.52	7.81	5.95	7.35	5.38
Available water %	12.64	15.12	11.50	12.56	11.15	11.95	10.75	11.30	9.96	10.39
Quickly drainable pores	9.33	7.35	6.67	7.02	5.21	6.24	4.83	5.14	3.65	4.63
Slowly drainable pores	10.12	9.81	8.82	9.25	6.25	7.57	5.74	6.73	4.78	5.85
Water holding pores	12.64	15.12	11.50	12.56	11.15	11.95	10.75	11.30	9.96	10.39
Fine capillary pores	13.26	17.65	15.52	15.85	18.21	16.05	16.32	15.48	18.31	16.82
Useful pores	22.76	24.93	20.32	21.81	17.40	19.52	16.49	18.03	14.74	16.24
Na_2SO_4										
Soil strength (kg/m^2)	3.04	2.39	3.12	2.55	3.17	2.62	3.22	2.74	3.25	2.87
Bulk density (g/cm^3)	1.30	1.26	1.31	1.28	1.33	1.30	1.34	1.31	1.36	133
Total porosity %:	45.35	49.93	44.74	48.08	43.85	47.13	42.32	45.50	41.17	44.26
Hydr. Cond. (cm/h)	9.21	7.84	9.13	8.92	8.96	8.75	8.61	8.42	8.35	8.06
Available water %	12.64	15.12	12.04	14.21	11.59	12.36	11.41	12.71	11.05	12.64
Quickly drainable pores	9.33	7.35	8.34	8.07	7.71	9.58	6.35	8.18	5.14	6.95
Slowly drainable pores	10.12	9.81	10.16	10.28	8.83	10.91	7.58	8.64	7.36	8.40
Water holding pores	12.64	15.12	12.04	14.21	11.59	12.36	11.41	12.71	11.05	12.64
Fine capillary pores	13.26	17.65	14.20	15.52	15.72	14.28	16.98	15.97	17.62	16.27
Useful pores	22.76	24.93	22.20	24.49	20.42	23.37	18.99	21.35	18.41	21.04

b. Soil chemical properties:

Data in Tables (4 and 5) show the hazardous effects of the applied water salinity levels, which considerably affect many soil properties through the concomitant accumulation of salts and their specific anions. The values of soil ECe, pH and ESP tended to increase with increasing water salinity levels, with a greatly affect for those irrigated with Na_2CO_3 solution that exhibited progressive increases in these values due to the specific effect of both the free ions of Na^+ and CO_3^{2-}. The later case may be created by the negative effect of specific ions (Na^+ and CO_3^{2-}) on depressing the volume of drainable pores due to the degradation of soil aggregates and the dispersion of soil particles. However, the continuous usage of saline water built up salts in irrigated soils, which exerted certain changes in soil properties as mentioned before. The accumulated salts were proportionally increased with increasing the water salinity levels. Thus, the magnitudes of soil ECe, pH and ESP values in the studied soil as hazardous affect due to the applied water salinity levels are shown in the following order: Na_2CO_3 > NaCl > Na_2SO_4.

Table (4): Effect of the applied water salinity levels and specific effect of anions on soil pH, salinity and soluble ion distribution patterns.

Salt type	Salt conc. (mg/L)	Soil pH**	ECe (dS/m)	Soluble cations (m molc L^{-1})				Soluble anions (m molc L^{-1})			
				Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}
Cont	250	8.13	3.87	11.85	7.60	19.25	0.40	0.00	2.90	22.45	13.75
	250*	7.92	3.02	9.25	5.85	15.30	0.35	0.00	2.80	17.50	10.45
NaCl	600	8.15	4.26	13.79	10.61	18.02	0.55	0.00	2.75	30.47	9.75
	600*	8.09	3.75	12.14	9.31	15.90	0.50	0.00	2.70	26.80	8.35
	1200	8.17	5.06	13.22	11.43	25.85	0.65	0.00	2.65	36.50	12.00
	1200*	8.12	4.49	11.73	10.12	22.90	0.55	0.00	2.55	32.40	10.35
	2400	8.21	7.34	13.91	10.74	48.75	0.80	0.00	2.60	51.95	19.65
	2400*	8.17	6.53	12.37	9.43	43.50	0.70	0.00	2.50	46.25	17.25
	4800	8.26	8.58	11.78	8.22	65.90	0.85	0.00	2.55	64.50	19.70
	4800*	8.20	7.12	9.75	6.80	54.70	0.75	0.00	2.45	53.00	16.55
Na_2CO_3	600	8.22	5.36	15.28	8.02	30.25	0.55	0.45	4.15	33.65	15.85
	600*	8.14	4.95	14.10	7.40	27.90	0.50	0.30	3.80	31.00	14.80
	1200	8.57	7.21	17.01	12.54	42.60	0.80	1.10	5.80	47.75	18.30
	1200*	8.51	6.73	15.85	11.65	39.70	0.75	0.50	4.95	45.00	17.50
	2400	8.78	9.06	16.99	13.71	60.00	0.85	1.85	6.75	56.50	26.45
	2400*	8.67	8.25	15.50	11.40	55.50	0.80	0.95	6.10	52.00	24.15
	4800	9.13	10.95	20.07	15.63	73.80	1.05	2.30	7.35	73.50	27.40
	4800*	8.98	9.87	18.10	14.25	66.00	0.95	1.50	6.45	68.50	22.85
Na_2SO_4	600	7.96	3.98	11.31	8.69	19.75	0.60	0.00	2.70	12.50	25.15
	600*	7.89	3.21	9.15	7.00	15.90	0.50	0.00	2.60	10.10	19.85
	1200	7.99	4.56	12.07	7.38	26.00	0.75	0.00	2.65	16.00	27.55
	1200*	7.93	3.79	10.03	6.12	21.60	0.60	0.00	2.55	13.30	22.50
	2400	8.03	6.72	15.72	10.13	41.50	0.90	0.00	2.50	22.00	43.75
	2400*	7.98	5.58	13.05	8.45	34.25	0.75	0.00	2.25	18.30	35.95
	4800	8.08	7.94	17.02	13.13	46.90	1.20	0.00	2.45	27.50	48.30
	4800*	8.04	6.72	15.20	10.95	39.60	1.00	0.00	2.30	22.90	41.55

*Soil treaded with organic manure at a rate of 30 m^3/fed **1 : 2.5 soil water suspension

As a general view, the obtained results after about 90 days of planting indicated that building up of soil salinity was influenced not only by water salinity levels but also by the specific anion effect. On basis of ECe value, there were differences in the values of salinity build up through applying NaCl and Na_2SO_4 solutions as soil salinity was generally greater in the case of applying NaCl solution than that of Na_2SO_4 one, probably due to the formation of false soil aggregates in the later case that caused sufficient soil drainage, and in turn enhanced the removal of some excess salts under the flooding system. On the other hand, data cleared that, greatly increased soil salinity accompanied raising salinity levels of Na_2CO_3 solution, where the relative increases in ECe of soil irrigated with Na_2CO_3 at the highest salinity level of 4800 mg/L reached about 1.3 and 1.4 folds of those irrigated with NaCl and Na_2SO_4 solutions, respectively.

The distribution patterns of soluble ions among the saline water treated soil, Table (4), indicated that, actually, the magnitude of ion changes was proportional to the chemical composition of the irrigation water used, however, alternating saline water provokes replacement of soil solution and thus results in different ionic concentrations. In general, the distribution pattern of soluble cations in soils irrigated with the applied saline irrigation waters followed an ascending order: $Na^+ > Ca^{2+} > Mg^{2+} > K^+$, while the soluble anions could be arranged as $Cl^- > SO_4^{2-} > HCO_3^-$ in the case of NaCl and Na_2CO_3 vs $SO_4^{2-} > Cl^- > HCO_3^-$ in the case of Na_2SO_4.

c. <u>Available nutrient contents:</u>

Data illustrated in Table (5) indicated that the available contents of the studied macro- (N, P and K) and micronutrients (Fe, Mn, Zn and Cu) in soils irrigated with the tested saline water gradually decreased with increasing water salinity levels as compared to that irrigated with the fresh Nile water, with the exception of Fe and Mn in soil treated with Na_2CO_3 solution. The later case was more associated with the dominance of the poor-aeration condition, which enhances the occurrence of Fe^{2+} and Mn^{2+} under the reduction phase.

In general, the relative decrease in available nutrient contents may be attributed to the unsuitable air-moisture regime that control the availability of nutrients, beside the depressive effect of salinity stress of both irrigation water and soil on the released nutrient from either organic residues or nutrient bearing minerals. These findings are supported by those obtained by **Hegazi (1999)** who found a negative correlation between salinity and available plant nutrients in soil. In addition, the unsuitable air-moisture regime in such calcareous soils negatively affected biological activity and the supply of available nutrients, particularly from the organic source.

Role of applied organic manure for alleviating the hazardous effects:

Data presented in Tables (4 and 5) showed that application of organic manure resulted in improving soil chemical properties as well as soil fertility status against the hazardous effects of using saline water as a source for irrigation. The values of organic matter and available nutrients (N, P, K, Fe, Mn, Zn and Cu) exhibited pronounced increases in all soil pots treated with saline water under the different salt types and levels when amended with organic manure at the rate of 30 m^3/fed. The opposite trend was true for each of soil pH, ECe and ESP, since their values tended to decrease. These beneficial effects are due to the active organic acids that released from the bio-chemical reactions **(Abdel-Aziz *et al.*, 1996 and Basyouny, 2002).** As a general view, reducing ECe and ESP value were generally achieved through applying organic manure, probably due to the positive effect of active organic acids on formation of stable soil aggregates that caused sufficient soil drainage, and in turn enhanced the removal of excess salts under the flooding system. On the other hand, the released CO_2 during organic matter decomposition greatly increased $CaCO_3$ solubility that accompanied raising Ca^{2+} levels in soil solution and hence lowering ESP values.

Table (5): Effect of the applied water salinity levels and specific effect of anions on $CaCO_3$, organic matter, ESP and available nutrients in the studied soil.

Salt type	Salt conc. (mg/L)	$CaCO_3$ %	Organic matter %	ESP	Available nutrients (mg kg^{-1} soil)						
					Macronutrients			Micronutrients			
					N	P	K	Fe	Mn	Zn	Cu
Cont	250	22.32	0.41	8.56	27.13	5.52	145.06	5.91	1.75	1.09	0.96
	250*	21.78	0.53	7.38	36.34	7.56	197.72	8.05	2.51	1.46	1.32
NaCl	600	21.95	0.37	9.45	24.92	5.07	141.84	4.88	1.54	0.95	0.88
	600*	21.52	0.43	8.62	28.91	5.88	164.53	5.82	1.79	1.10	1.02
	1200	21.78	0.35	10.83	21.36	3.49	139.45	4.54	1.38	0.86	0.82
	1200*	21.36	0.41	9.58	24.78	4.05	161.76	5.43	1.60	0.99	0.95
	2400	21.60	0.32	12.07	19.94	3.92	137.08	4.31	1.22	0.76	0.73
	2400*	21.25	0.37	10.79	23.14	4.55	159.01	5.15	1.41	0.88	0.85
	4800	21.54	0.30	14.62	16.02	3.36	135.62	4.02	1.08	0.70	0.64
	4800*	21.18	0.35	12.38	18.58	3.90	157.32	4.82	1.25	0.81	0.74
Na_2CO_3	600	22.34	0.35	13.12	22.87	4.75	138.30	6.23	1.95	0.82	0.73
	600*	22.06	0.38	11.93	24.93	5.18	150.75	6.88	2.12	0.89	0.79
	1200	22.37	0.32	15.64	19.73	4.18	136.85	7.05	2.32	0.73	0.65
	1200*	22.11	0.35	12.49	21.51	4.56	149.17	7.77	2.53	0.80	0.71
	2400	22.39	0.29	18.73	15.27	3.52	134.01	8.64	2.69	0.60	0.56
	2400*	22.15	0.32	14.94	16.64	3.84	146.17	9.21	2.91	0.65	0.61
	4800	22.42	0.25	23.85	13.95	2.96	131.56	9.05	2.85	0.51	0.47
	4800*	22.18	0.27	17.91	15.20	3.23	143.40	9.86	3.12	0.59	0.53
Na_2SO_4	600	21.87	0.39	8.92	25.43	5.27	142.54	5.15	1.69	0.98	0.91
	600*	21.53	0.49	7.53	31.28	6.48	174.65	6.56	2.08	1.20	1.12
	1200	21.70	0.38	9.45	22.92	4.91	141.37	4.97	1.52	0.92	0.86
	1200*	21.37	0.47	8.03	28.19	6.03	173.87	6.25	1.87	1.13	1.06
	2400	21.65	0.35	9.87	21.07	4.56	139.61	4.73	1.36	0.83	0.80
	2400*	21.22	0.43	8.43	25.92	5.61	171.72	6.05	1.65	1.02	0.98
	4800	21.59	0.31	11.63	19.87	4.15	137.92	4.41	1.23	0.74	069
	4800*	21.26	0.38	10.12	24.45	5.10	169.62	5.62	1.51	0.91	0.85

Critical levels of nutrients (mg/kg) after Lindsay and Norvell (1978) and Page et al. (1982)

Limits	N	P	K	Fe	Mn	Zn	Cu
Low	< 40.0	< 5.0	< 85.0	< 4.0	< 2.0	< 1.0	< 0.5
Medium	40.0-80.0	5.0-10.0	85.0-170.0	4.0-6.0	2.0-5.0	1.0-2.0	0.5-1.0
High	> 80.0	> 10.0	> 170	> 6.0	> 5.0	> 2.0	> 1.0

*Soil treaded with organic manure at a rate of 30 m^3/fed.

The magnitudes of available nutrients in the initial state of the tested calcareous soil, Tables (1 and 5) showed that the studied nutrients (N, P, K, Fe, Mn, Zn and Cu) lay within the low-medium level, according to the critical levels of nutrients undertaken by **Lindsay and Norvell (1978)**. In general, this is true since this soil is not only poor in the nutrient-bearing minerals, but also in organic matter content, which are considered as storehouse for the essential plant nutrients. In addition, there are adverse effects represented by the prevailing calcareous nature of soil that restricts nutrients availability. On the other hand, the results obtained of the organic manure treated soil showed progressive increases in the available N, P, K, Fe, Mn, Zn and Cu as compared to those untreated. It is noteworthy that increasing available nutrient contents was achieved upon treating the soil with the applied rate of the studied organic manure, due to its narrow C/N ratio and its high content of essential macro and micronutrients.

II. Characteristics of elephant grass as affected by saline water:

a. Vegetative growth parameters:

Data presented in Table (6) show the hazardous effect of water salinity stress on some vegetative growth parameters, i.e., germination percentage and dry weight of plants/pot.

Table (6): Effect of applied water salinity levels and specific anions on germination percentage and dry weight of elephant grass plants.

Salt type	Salt concen-tration ($mg\ l^{-1}$)	Germination percentage		Dry weight ($g\ pot^{-1}$)			
				First cut		Second cut	
		Organic manure (m^3/fed)					
		0	30	0	30	0	30
Cont.	250	100	100	62.45	73.65	48.92	60.03
NaCl	600	85	90	44.53	52.74	39.40	45.71
	1200	80	85	37.46	43.25	35.76	42.54
	2400	70	75	31.90	38.47	28.95	34.85
	4800	65	70	26.01	31.81	23.08	28.32
Na_2CO_3	600	75	80	31.79	36.92	25.36	32.69
	1200	60	70	26.63	31.43	21.67	27.75
	2400	45	55	21.20	26.78	17.48	22.49
	4800	35	45	16.71	20.63	9.97	14.05
Na_2SO_4	600	90	95	52.47	60.32	46.38	53.07
	1200	85	90	43.63	51.09	41.93	49.81
	2400	80	85	37.08	45.25	34.10	41.53
	4800	75	80	29.51	36.78	25.84	32.27
L.S.D. at 0.05							
Salt (S)		3.20		2.31		1.72	
Concentration (C)		7.83		8.01		6.54	
Organic manure (O)		3.50		5.71		4.32	
S x C		2.35		3.45		2.34	
S x O		5.73		4.83		4.40	
C x O		1.56		2.11		1.91	
S x C x O		9.45		7.22		8.54	

Data in Table (6) indicate that increasing the applied water salinity levels for all of the tested salts was associated with significant decreases in all the studied vegetative parameters. This may be due to the depressive effect of salt stress on plant growth, which is attributed to its uptake or ability to accumulation of salts in plant tissues at a hazard level. However, it can be deduced that the higher the water salinity the lower the vegetative parameters under investigation. It is worthy to mention that the magnitudes of reduction differed from salt to another with a significant difference. The highest reduction was observed with the Na_2CO_3 solution, while the least occurred with Na_2SO_4 one, reflecting the specific effect of accompanied anion. The reductions in vegetative growth parameters may be due to decreasing the net photosynthesis, stomata conductance and transpiration rate under salinity stress of irrigation water **(Naire and Khuble, 1990)**. These findings are statistically emphasized by the significant differences between salt types, levels and their interactions, Table (6).

b. Nutrients uptake by elephant grass plants:

Data that pertaining the hazardous effects of the applied saline water on plant contents of nutrients (N, P, K, Fe, Mn, Zn and Cu) determined at 45 days after sowing for the grown elephant grass plants (first cut) are illustrated in Table (7).

Table (7): Effect of the applied water salinity levels and specific effect of anions on nutrient contents uptake by elephant grass plants.

Salt type	Salt conc. (mg/L)	Available nutrients						
		Macronutrients %			Micronutrients (mg kg^{-1} soil)			
		N	P	K	Fe	Mn	Zn	Cu
Cont	250	2.92	0.36	2.59	78.61	54.32	29.15	16.80
	250*	3.45	0.39	3.17	91.54	65.75	35.07	19.44
NaCl	600	2.39	0.32	2.34	71.72	49.64	26.09	13.37
	600*	2.75	0.37	2.69	82.40	57.03	29.98	15.41
	1200	2.27	0.31	2.21	67.10	46.91	22.64	11.02
	1200*	2.61	0..36	2.54	77.09	53.90	26.01	12.67
	2400	2.04	0.30	2.09	61.67	44.57	17.10	9.86
	2400*	2.34	0.34	2.40	70.87	51.21	19.65	11.34
	4800	1.96	0.28	1.87	57.93	41.08	14.76	8.21
	4800*	2.25	0.32	2.15	66.56	47.20	16.96	9.45
Na_2CO_3	600	1.94	0.29	2.08	60.60	46.03	19.08	10.84
	600*	2.11	0.32	2.27	66.05	50.17	20.79	11.85
	1200	1.81	0.27	1.82	56.41	44.12	16.25	9.07
	1200*	1.97	0.29	1.98	61.50	48.09	17.71	9.91
	2400	1.73	0.24	1.63	53.32	41.97	12.61	7.13
	2400*	1.89	0.26	1.78	58.12	45.75	13.74	7.69
	4800	1.65	0.23	1.51	51.02	39.62	10.34	6.72
	4800*	1.80	0.25	1.65	55.60	43.20	11.31	7.32
Na_2SO_4	600	2.76	0.35	2.46	73.55	50.23	28.75	15.06
	600*	3.28	0.42	2.92	87.43	59.71	34.18	17.90
	1200	2.61	0.33	2.32	70.16	48.56	24.93	13.71
	1200*	3.10	0.39	2.76	83.40	57.73	29.64	16.30
	2400	2.35	0.32	2.18	66.95	45.90	21.02	10.95
	2400*	2.79	0.38	2.59	79.59	54.56	24.99	13.01
	4800	2.16	0.30	1.95	62.78	43.08	16.85	9.64
	4800*	2.57	0.36	2.32	74.63	51.21	20.03	11.46

*Soil treaded with organic manure at a rate of 30 m^3/fed.

The obtained data showed a relative decrease in nutrient contents of the grown elephant grass plants irrigated with saline water. The lowest uptake values were attained at the high water salinity level (4800 mg L^{-1}). This adverse effect is not only due to the restricted supplying power for available nutrients in the studied soils, but also is owing to the unsuitable environmental media in the root zone, especially air-moisture regime that inhibited the mechanism of nutrients uptake by plant roots, besides of the depressive effect of osmotic potential and specific ion effect on plant growth **(Amer, 1999)**. This is due to the inability of subcellular osmotic units to overcome the relatively high osmotic pressure of soil solution resulted due to the high ionic strength **(Khater *et al.,* 2002)**. Moreover, the calcareous nature, released Ca^{2+}, high soil pH and sodication, actually restricted phosphorus and micronutrients availability.

Role of applied organic manure for alleviating the hazardous effects:

Undoubtedly, the beneficial effects of applied organic manure as a soil amendment extended to the biological activity and the fertility status of such newly reclaimed calcareous soils, however, the vegetative growth characters went on significant increases due to application of the recommended rate of organic manure, Table (6). The magnitudes of these increments differed according to the applied salt types, where the relatively high and low increments were observed with Na_2SO_4 and Na_2CO_3, respectively, with a significant difference. This is possibly due to the specific effects of the accompanied anions against the beneficial role of active organic acids on improvement of soil properties as well as nutrients availability or mobility towards plant roots. Also, the improvement of the growth parameters may be resulted from increasing the net photosynthesis, stomata conductance and transpiration rate when the grown elephant grass plants were subjected to the prevailing best conditions of soil environmental media **(Naire and Khuble, 1990)**.

Finally, the applied organic manure might result in an increase in active organic acids, which positively affected the studied soil physio-chemical properties and enhanced the availability of both essential macro- and micronutrients (N, P, K, Fe, Mn, Zn and Cu), Table (7). These aspects are considered more effective under restrictive conditions of such calcareous soil media. Moreover, the applied organic manure contain a pronounced content of these essential nutrients as well as being considered as a storehouse for nutrients with easily mobile or available to uptake by plant roots.

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دلالة إضافة المخصب العضوى لتقليل التأثيرات الضارة لملوحة المياه والتأثير النوعى للأنيونات على بعض خواص أرض جيرية والنباتات النامية بها

عبد الناصر أمين أحمد عبد الحفيظ

قسم الأراضى والمياه – كلية الزراعة – جامعة الفيوم – مصر

أجريت تجربة أصص خضرية داخل الصوب على أرض جيرية (٠-٣٠ سم) حديثة الإستصلاح ذات قوام طميى رملى وتحتوى على حوالى ٢٢٪ كربونات كالسيوم مأخوذة من محطة تجارب دمو – كلية الزراعة – جامعة الفيوم، لدراسة التأثير الضار الناجم عن إستخدام مياه مختلفة فى مستويات ملوحتها (٣٠٠، ٦٠٠، ١٢٠٠، ٢٤٠٠، ٤٨٠٠ مجم/لتر)، وكذلك التأثير النوعى للأنيونات (Cl^-, $CO3^{--}$ and $SO4^{--}$) على بعض خواص كل من التربة والنباتات النامية. كما وأن إستجابة الخواص المدروسة للتربة والنباتات النامية (حشيشة الفيل كعلف صيفى اخضر مستحدث زراعته بمحافظة الفيوم) لإضافة مخصب عضوى (مكمورة مخلفات نباتية بمعدل ٣٠ م٣/فدان) كانت محل إهتمام هذه الدراسة.

وتوضح النتائج المتحصل عليها أن هناك تأثيرات معاكسة على الخواص الفيزيوكيميائية للتربة وكذا الخصوبية تحت الدراسة (الكثافة الظاهرية، درجة مقاومة الطبقة السطحية من التربة للإختراق، المسامية الكلية للتربة، التوصيل الهيدروليكى، الماءالميسر، التوزيع الحجمى للمسام، المادة العضوية، الرقم الهيدروجينى، النسبة المئوية للصوديوم المتبادل، والمحتوى من المغذيات الميسرة فى التربة) بزيادة مستويات ملوحة المياه. وكانت هذه التأثيرات السلبية غير مرتبطة بمستويات ملوحة المياه فقط بل أيضا بالتأثير النوعى للأنيونات، حيث تفوق التأثير الضـــار لمـــلح Na_2CO_3 على مســـــتويات ملـــحى NaCl and Na_2SO_4 لتأثيره المدمر على مجمعات التربة. وفى هذا الخصوص، أمكن ترتيب الأنيونات المصاحبة تبعا لتأثيراتها الضارة تنازليا فيما يلى: $CO_3^{2-} > Cl^- > SO_4^{2-}$.

وتشير النتائج إلى أن التأثيرات الضارة لمستويات ملوحة المياه على خواص التربة السابق الإشارة إليها قد إمتد إلى النمو الخضرى (نسبة الإنبات، والوزن الجاف) والمغذيات الممتصة بواسطة نباتات حشيشة الفيل النامية، حيث ظهر نقص تدريجى بزيادة مستويات تركيز الأملاح فى المياه. وكان ذلك أكثر إرتباطا بالتأثير الضار لإرتفاع مستوى ملوحة المحلول الأرضى على تثبيط إمتصاص المغذيات بواسطة جذور النباتات. كما لوحظ من النتائج المتحصل عليها أن إضافة المكمور العضوى (مكمور مخلفات نباتية) بمعدل ٣٠م٣/فدان قد أدى إلى تقليل كثير من التأثيرات المعاكسة لمستويات ملوحة المياه وتأثيراتها النوعية على خواص التربة والنبات تحت الدراسة. وبصفة عامة، فان إضافة المخصب العضوى (مكمورة مخلفات نباتية) قد تسبب فى حدوث زيادة فى محتوى التربة من الأحماض العضوية النشطة والتى لها تأثيرات إيجابية على خواص التربة تحت الدراسة، كما أدى إلى زيادة تيسر المغذيات الكبرى والصغرى الضرورية للنبات (N, P, K, Fe, Mn, Zn and Cu). والحالة الأخيرة تعتبر أكثر فاعلية تحت الظروف المعاكسة لبيئة التربة ذات الطبيعة الجيرية، بالإضافة إلى إحتواء المخصب العضوى المضاف على كمية محسوسة من تلك المغذيات الضرورية للنبات.