Menoufia J. Soil Sci., Vol. 4 April (2019) : 113 - 128

IMPACT OF SOIL SALINITY ON AVAILABLE MACRO NUTRIENTS UPTAKE BY WHEAT PLANT

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Received: Feb. 16, 2019 **Accepted: Feb. 28 , 2019**

ABSTRACT: ***In Egypt, the soil salinity is the mainly constraint to the development of agricultural sector. In the last few decades, the farmers and the government have made a great effort to diminish the hazard of soil salinity. The resistance of soils to salinity processes by human positive actions is known as soil resilience. This study aims to assess the soil salinity and resilience at north of Nile Delta and evaluate their impact on macro nutrients uptake by wheat plant. To fulfill these objectives, (i) field survey for identifying the main soil physical and chemical properties as well as the nutrients status in soils of the study area were carried out, (ii) explore the effects of salinity on the macronutrients uptake and ionic relations, and to (iii) status of macronutrients in soils and wheat plant in salinity environments. The results showed that the textural classes of these soils were clay were determined in cultivated land. In addition, The CEC range between 26.49 to 33.03Cmolc kg^{-1}, total $CaCO_3$ was range between 0.91 to 3.04 % and the gypsum was range between 1.69 to 5.64 %. The dominant soluble cations were Na^{+} followed by Ca^{+2} and Mg^{+2} while K^{+} was rather low in a descending order. On the other hand, soluble anions were dominated by Cl^{-} and SO_4^{-2}. Results on correlations of EC with macronutrients in the soils, it gives strong positively correlation and regression of EC constant with available macronutrients. The present study confirms that at all salinity levels the variation in germination, plant growth, dry matter accumulation, ionic strength and availability of nutrients in seeds and straw could be better explored in determining the tolerance capacity of the wheat cultivars.***

Key words: ***Soil salinity, available macronutrients, wheat.***

INTRODUCTION

Soil salinity is defined as the process, which lowers (quantitatively or qualitatively) the current and/or the potential suitability of soil to produce goods or services. Nutrient disturbances under both drought and salinity reduce plant growth by affecting the availability, transport and partitioning of nutrients. However, drought and salinity can differentially affect the mineral nutrition of plants (Hu and Schmidlter, 2005).

Salt affected soils occur commonly in arid and semi-arid regions and characterized by excessively high levels of water- soluble salts. In most cases, sodium chloride is a major salt contaminant in such soils, it has a small molecule size and when oxidized by water, produces Na+ and Cl- ions, which are easily absorbed by the root cells of higher plants and transferred to the whole plant causing ionic and osmotic stresses at the cellular level of such plants (Rodriguez *et al*., 2006).

Salinity may cause nutrient deficiencies or imbalance because of the competition of more Na and Cl ions with nutrients such as K^{+}, Ca^{2+} and NO_3^{-}. Drought, on the other hand, can affect nutrient uptake and impair acropetal translocation of some nutrient. A better

understanding of the role of mineral nutrient in plant resistance to drought and salinity will contribute to improve fertilizer management in arid and semi-arid areas and in regions suffering from temporary drought (Hu *et al*., 2017).

Salt- affected soils can be classified according to how the salinity developed: primary salinity which occurs naturally where the soil parent materials rich in soluble salts or geochemical processes result in salt-affected soil. Secondary salinity is salinization of land and water resources due to human activities. Human activities which can induce salinization include poor irrigation management; insufficient drainage; improper cropping pattern sand rotations and chemical contamination (Oldeman, *et al*., 1990 and UNEP, 2007).

Wheat is moderately tolerant to salinity Genc *et al.,* (2007), and its growth and physiological responses to salinity stress have been extensively studied (Saqib *et al.,* 2005; Munns and Tester 2008; Saqib *et al*., 2013; Rahnama *et al*., 2011 and McDonald *et al*., 2015). However, the morpho-physiological responses of wheat to the combined effects of salinity and low macronutrients (N, P and K) have not been well understood.

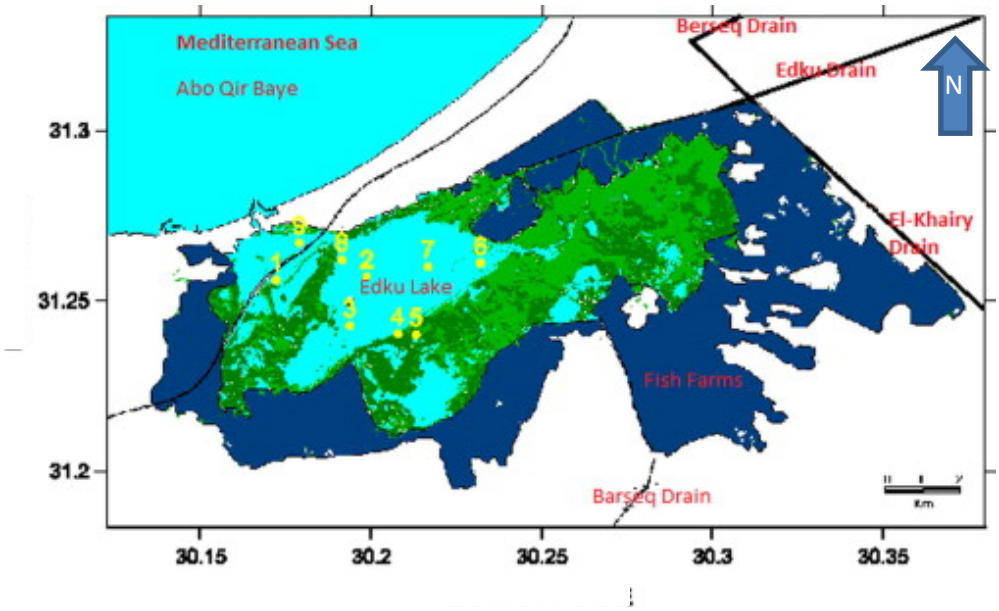
To address these objectives, we used salinity-tolerant bread wheat (Triticum aestivum L.) cultivar Janz, which is P-inefficient (Osborne and Rengel 2002 and Zaicou *et al*., 2002) and salinity-sensitive durum wheat (Triticum turgidum L.) cultivar Jandaroi, which is also P-inefficient (Shamaya, 2014 and Schwenke *et al*., 2015). We hypothesized that wheat cultivars would respond differently to salinity and low macronutrients interaction, and the combined stress of low macronutrients and salinity would be more detrimental on these attributes than their individual effects.

The main objectives of this study were to: (i) Identifying the main soil physical and chemical properties as well as the nutrients status in soils of the study area, (ii) explore the effects of salinity on the macronutrients uptake and ionic relations, and to (iii) determine the macronutrients in soils and wheat plant in salinity environments.

MATERIALS AND METHODS

The study area is located at the north of the Nile Delta between latitude 32^{o} 10' and 31^{0} 45' N, and longitudes 30^{o} 27' and $35^{0}20^{'}$ E "Edko region- The governorate of Albehira". The collected soil samples represent 15 profiles with 2 depths (0-35cm and 35-100cm) were illustrated in Map (1) air dried, crushed, sieved to pass a 2mm sieve and preserved for further analyses and plant samples were taken for macronutrient analysis. The governorate of Albehira comes first as to fruits and vegetables production, and export of citrus, potatoes, tomatoes, artichoke, watermelon, string beans and pepper.

***Soils analysis*: Particle size distribution was estimated using the Pipette Method as described by Piper (1950). OM content was determined using the Walkley and Black according to the method outlined by Jackson, (1967). Soil pH was measured in 1:2.5 according to (Van Reeuwijk, 1993). CEC was determined by using *sodium acetate* at pH 8.2 for saturation and *ammonium acetate* at pH 7.0 according to Bower *et al.*, (1952). Gypsum content was measured according to Schoonover, (1952). CaCO3 content was measured according to Wright, (1939). ESP is calculated by the formula of Allison *et al., (*1954). EC is commonly used for indicating the total ionized concentration of solutions and soluble cations and anions according to Reitemerir, (1943). Available N and Available K were determined according to Page *et al*., (1982). Available P was determined according to Olsen *et al*., (1954).**



Map (1): The studied area for Edko region.

***Plant analysis*: available N was determined according to Chapman and Pratt, (1961), available P was determined according to Holman and Elliot, (1983), available K was determined according to Page *et al*., (1982).**

***Statically analysis*: *SPSS (version 20) and Microsoft Office Excel 2007* were used to determine the descriptive statistics and correlation analysis between soils and plant results. *SPSS* technology has made difficult analytical tasks easier through advances in usability and data access, enabling more people to benefit from the use of quantitative techniques in making decisions (SPSS, 2015), as following in Table (5). Correlation and regression analyses were carried out to detect functional relationship between soils and plant results.**

RESULTS AND DISCUSSION

Particle size distribution: The soil separates (clay, silt and sand fractions) were significantly different cross the land use. Data in Table (1) reveal that the clay fraction content ranged between 66.23 to 89.01 %; and tends to increase with soil profiles depths. Considering the silt content, it was ranged between 9.89 to 33.00 %. In addition, it was shown the sand content varied between 0.32 to 2.13 %. These results showed that the textural classes of these soils were clay. This may imply poor drainage cause to restrict effect on the yield potential of the studied area.

Some chemical properties: the results obtained, show that Na, Ca, Mg and K in the soils studied were high. The CEC range between 26.49 to 35.60Cmolc kg^{-1} was high. As the soils were generally low in organic matter content, whereas OM range between 0.01 to 0.5 %. It is probable that the CEC obtained could be as results of the presence of high activity montmorillonitic 2:1 clay mineral. The results showed that total $CaCO_3$ content was ranged between 0.91 to 3.04 % Soil $CaCO_3$ is identified as an important soil criterion for agricultural crops in the Mediterranean region. This criterion affects soil moisture regime and

availability of nutrients to plants, pH, and dispersion-flocculation and OM stabilization. The gypsum values varied between 1.69 to 5.64 % as shown in Table (1). The particular properties associated with gypsum imparts to soils affect to a great extent soil development including soil morphology accumulations of pedogenic gypsum which influences water holding capacity, nutrient, water availability for plants, root growth and the standard concepts of soil texture and rapture resistance.

Table (1): Particle size distribution, texture class and some chemical properties for the studied area:

Profiles	Depth cm	Particle size distribution (%)				Soil chemical properties or $CaSO_4$			
		Clay	Silt	Sand	Texture	CEC (Cmolc kg-1)	OM %	CaCO3 %	Gypsum %
1	0-35	76.25	22.45	1.30	Clay	30.50	0.31	2.07	3.84
	35-100	77.91	21.77	0.32	Clay	31.16	0.08	2.00	3.72
2	0-35	69.58	28.95	1.47	Clay	27.83	0.35	2.66	4.95
	35-100	71.89	28.00	0.11	Clay	28.76	0.03	2.58	4.79
3	0-35	80.36	17.86	1.78	Clay	32.14	0.42	1.64	3.05
	35-100	89.01	9.89	1.10	Clay	35.60	0.26	0.91	1.69
4	0-35	78.90	20.00	1.10	Clay	31.56	0.26	1.84	3.42
	35-100	66.23	32.08	1.69	Clay	26.49	0.40	2.95	5.48
5	0-35	66.54	33.00	0.46	Clay	26.62	0.11	3.04	5.64
	35-100	71.20	26.87	1.93	Clay	28.48	0.45	2.47	4.59
6	0-35	68.63	30.37	1.00	Clay	27.45	0.24	2.79	5.19
	35-100	70.25	29.00	0.75	Clay	28.10	0.18	2.67	4.96
7	0-35	67.39	31.58	1.03	Clay	26.96	0.24	2.91	5.40
	35-100	70.00	29.85	0.15	Clay	28.00	0.04	2.75	5.10
8	0-35	70.85	29.00	0.15	Clay	28.34	0.04	2.67	4.96
	35-100	77.47	22.50	0.03	Clay	30.99	0.01	2.07	3.85
9	0-35	67.25	31.40	1.35	Clay	26.90	0.32	2.89	5.37
	35-100	67.88	31.11	1.01	Clay	27.15	0.24	2.86	5.32
10	0-35	74.00	24.58	1.42	Clay	29.60	0.33	2.26	4.20
	35-100	74.98	24.51	0.51	Clay	29.99	0.12	2.25	4.19
11	0-35	80.25	19.00	0.75	Clay	32.10	0.18	1.75	3.25
	35-100	82.58	16.89	0.53	Clay	33.03	0.12	1.55	2.89
12	0-35	78.58	20.25	1.17	Clay	31.43	0.28	1.86	3.46
	35-100	80.00	17.87	2.13	Clay	32.00	0.50	1.64	3.05
13	0-35	69.37	30.00	0.63	Clay	27.75	0.15	2.76	5.13
	35-100	70.48	29.00	0.52	Clay	28.19	0.12	2.67	4.96
14	0-35	75.44	23.54	1.02	Clay	30.18	0.24	2.17	4.02
	35-100	76.85	22.37	0.78	Clay	30.74	0.18	2.06	3.82
15	0-35	80.00	18.10	1.90	Clay	32.00	0.45	1.67	3.09
	35-100	81.69	17.00	1.31	Clay	32.68	0.31	1.56	2.91

Soils pH classification: in the present study most soils profiles have a pH in the values ranged of 8.18 to 8.76; indicating that these soils were slightly to moderately alkaline and most of soil pH is represented the presence of strong concentration of neutral soluble salts. Soil pH concentration is shown in Table (2) and it explains that more concentration is in northeastern part of the study area. Soil pH can affect CEC and AEC by altering the surface charge of colloids. A higher concentration of H^+ (lower pH) will neutralize the negative charge on colloids, thereby decreasing CEC and increasing AEC. The opposite occurs when pH increases.

Table (2): Status of pH soil, EC and soluble cations & anions for the studied area.

Profiles	Depth cm	pH soil (1:2.5)	EC dS m^{-1}	Soluble cations (mmolc L^{-1})				Soluble anions (mmolc L^{-1})			ESP %
				Ca^{2+}	Mg^{2+}	K^+	Na^+	Cl^-	HCO_3^-	SO_4^{2-}	
1	0-35	8.55	8.84	22.89	18.91	0.59	46.00	65.32	1.84	21.22	4.03
	35-100	8.52	8.57	21.39	17.68	3.64	43.00	61.06	1.79	22.86	3.85
2	0-35	8.68	11.40	29.11	24.06	2.28	58.52	83.10	2.38	28.50	4.71
	35-100	8.67	11.02	28.56	23.61	0.66	57.41	81.52	2.30	26.41	4.65
3	0-35	8.41	7.03	17.24	14.25	4.16	34.66	49.22	1.47	19.63	3.33
	35-100	8.18	3.89	9.45	7.81	2.67	19.00	26.98	0.81	11.14	2.13
4	0-35	8.47	7.87	19.53	16.14	3.82	39.25	55.74	1.64	21.36	3.62
	35-100	8.74	12.63	32.34	26.73	2.24	65.00	92.30	2.64	31.36	5.03
5	0-35	8.76	12.99	33.01	27.28	3.28	66.35	94.22	2.71	32.99	5.09
	35-100	8.65	10.58	27.47	22.70	0.41	55.21	78.40	2.21	25.18	4.53
6	0-35	8.70	11.96	29.98	24.77	4.57	60.25	85.56	2.49	31.52	4.79
	35-100	8.68	11.42	29.17	24.11	2.27	58.63	83.25	2.38	28.54	4.71
7	0-35	8.72	12.43	31.11	25.71	4.96	62.54	88.81	2.59	32.93	4.91
	35-100	8.71	11.75	30.35	25.08	1.09	61.00	86.62	2.45	28.45	4.83
8	0-35	8.68	11.42	29.02	23.99	2.82	58.34	82.84	2.38	28.95	4.70
	35-100	8.53	8.86	22.06	18.23	3.95	44.34	62.96	1.85	23.77	3.93
9	0-35	8.72	12.36	31.30	25.87	3.55	62.91	89.33	2.58	31.71	4.93
	35-100	8.73	12.25	31.59	26.11	1.28	63.50	90.17	2.56	29.75	4.95
10	0-35	8.59	9.68	24.80	20.49	1.64	49.84	70.77	2.02	23.98	4.24
	35-100	8.60	9.65	24.99	20.65	0.64	50.22	71.31	2.01	23.17	4.26
11	0-35	8.46	7.48	19.13	15.81	1.41	38.45	54.60	1.56	18.64	3.57
	35-100	8.40	6.65	16.85	13.93	1.85	33.87	48.10	1.39	17.01	3.28
12	0-35	8.50	7.97	20.66	17.07	0.48	41.52	58.96	1.66	19.10	3.76
	35-100	8.44	7.04	18.24	15.08	0.36	36.67	52.07	1.47	16.82	3.46
13	0-35	8.70	11.81	30.02	24.81	2.94	60.34	85.68	2.46	29.96	4.80
	35-100	8.68	11.42	29.28	24.20	1.85	58.85	83.57	2.38	28.22	4.72
14	0-35	8.57	9.27	23.81	19.67	1.35	47.85	67.95	1.93	22.80	4.13
	35-100	8.54	8.81	22.44	18.54	1.99	45.10	64.04	1.84	22.19	3.98
15	0-35	8.45	7.13	18.46	15.26	0.43	37.11	52.70	1.49	17.08	3.49
	35-100	8.42	6.69	17.30	14.30	0.55	34.78	49.39	1.40	16.15	3.34

Soil electrical conductivity (EC): EC is a useful indicator in managing agricultural system. In actuality, the interpretation of EC of a soil or media must be made considering the plant to be grown. EC is an electrolytic process that takes place principally through water filled pores. Cations (Na^+, Ca^{2+}, Mg^{2+} and K^+) and anions (Cl, SO_4 and HCO_3) from salts dissolved in soil water carry electrical charges and conduct the electrical current. Consequently, the concentration of ions determines the EC of soils. In the soils profiles studied, an EC values ranged of 3.89 to 12.63 dS m^{-1} (Table 2), indicating that the studied soils were very slightly saline to moderately saline. The results presented that high concentration is in (Edko region) of the study area. The highest ESP values were associated with high salinity and dominance of soluble sodium in the soil extract. Soluble cations were dominated by Na^+ followed by Ca^{+2} and Mg^{+2} while soluble K^+ ion was rather low in a descending order. On the other hand, soluble anions were dominated by Cl^- and SO_4^{-2}. High concentrations of neutral salts, such as NaCl and Na_2SO_4 may interfere with the absorption of water by plants because the osmotic pressure in the soil solution is nearly as high as or higher than that in the plant cells.

Available macro nutrients in soils: Macronutrients are of great the importance in controlling yield of crops. Soil characterization in relation to evaluation of macronutrients status of the soils of an area or regions is an important aspect in the context of sustainable agriculture production.

Available N status varied from 33.46 to 116.83 mg kg^{-1}; on the basis of the rating suggested by Lindsay and Norvell (1978), 60% of the soil samples were found to be high (97.21 to 116.83 mg kg^{-1}), 36% of the soils samples were found to be medium (61.03 to 79.70 mg kg^{-1}). On the other hand, Available P status varied from 4.16 to 7.77 mg kg^{-1}, 100% of the soil samples were found to be medium.

Available K status varied from 215.84 to 753.74 mg kg^{-1}, 100% of the soil samples were found to be high, as it is in shown Table (3). The relatively high available K amounts in the layers of the Nile alluvial sediments could be mainly attributed to the relatively high content of bound K-organic and K-exchangeable fractions (Aboukota, 2012 and 2016). I am interpret the higher content of available nutrients may be attributed to the higher application of NPK fertilizers on the tested soil.

Activates of macro nutrients in the soil solution are affected by high concentration of salts ions, usually Na^+ and Cl^-, resulting in a nutritional disorder in plants. Attention should be paid to the different ways of ions getting to the roots of plants. Three mechanisms are known in which nutrients reach the root surface, a prerequisite for nutrient uptake. These mechanisms are called root interception, mass flow and diffusion movement. Rates among these three mechanisms are variable, related to the chemical characteristics and behavior of the nutrient elements in soils.

The results indicated that N content status varied from 0.07 to 1.55% in wheat seeds and 0.14 to 1.69% in wheat straw; the N content is in some samples low. In adding, the P content at the level of profiles taken from the studied area is low, whereas range between 0.20 to 0.69% in seeds and in straw range between 0.15 to 0.34%. Except for profile No. 1, the results showed that the P rate in seeds both samples were sufficient. In addition, the wheat content of K is low in seeds and straw. Whereas range between 0.01 to 1.04% in seeds and in straw range between 0.66 to1.23%.

Table (3): Status of available macro nutrients for soil studied area.

Profiles	Depth cm	Available Macro- Nutrients (mg kg^{-1})					
		N	class	P	class	K	class
1	0-35	81.00	High	6.47	Medium	522.56	High
	35-100	75.71	Medium	6.25	Medium	488.48	High
2	0-35	103.04	High	7.30	Medium	664.79	High
	35-100	101.09	High	7.23	Medium	652.18	High
3	0-35	61.03	Medium	5.61	Medium	393.74	High
	35-100	33.46	Low	4.16	Medium	215.84	High
4	0-35	69.11	Medium	5.97	Medium	445.88	High
	35-100	114.45	High	7.69	Medium	738.40	High
5	0-35	116.83	High	7.77	Medium	753.74	High
	35-100	97.21	High	7.09	Medium	627.19	High
6	0-35	106.09	High	7.40	Medium	684.44	High
	35-100	103.24	High	7.30	Medium	666.04	High
7	0-35	110.12	High	7.54	Medium	710.45	High
	35-100	107.41	High	7.45	Medium	692.96	High
8	0-35	102.73	High	7.28	Medium	662.74	High
	35-100	78.07	Medium	6.35	Medium	503.70	High
9	0-35	110.77	High	7.56	Medium	714.66	High
	35-100	111.81	High	7.60	Medium	721.36	High
10	0-35	87.76	High	6.73	Medium	566.18	High
	35-100	88.43	High	6.76	Medium	570.50	High
11	0-35	67.70	Medium	5.91	Medium	436.79	High
	35-100	59.64	Medium	5.55	Medium	384.76	High
12	0-35	73.11	Medium	6.15	Medium	471.67	High
	35-100	64.57	Medium	5.78	Medium	416.57	High
13	0-35	106.25	High	7.41	Medium	685.46	High
	35-100	103.62	High	7.32	Medium	668.54	High
14	0-35	84.25	High	6.60	Medium	543.58	High
	35-100	79.41	Medium	6.40	Medium	512.34	High
15	0-35	65.34	Medium	5.81	Medium	421.57	High
	35-100	61.24	Medium	5.62	Medium	395.10	High

***Note: AV.*=available, Clas.*=classification. Critical level of the studied available plant nutrients (mg/kg), after Lindsay and Norvell (1978), [N <40.0 Low, 40.0-80.0 Medium, >80.0 High; P <5.0 Low, 5.0-10.0 Medium, >10.0 High; K<85.0 Low, 85.0-170.0 Medium; >170.0 High].**

The analysis of variance revealed a significant difference between salinity levels, in terms of macronutrients accumulation in the plants. The N, P and K contents in plants showed a higher level of salinity (Table 4).

Table (4): Status of macro nutrients to seeds and straw for wheat plant in the studied area.

Profiles	Depth cm	Macro- Nutrients concentration in seeds (%)			Macro- Nutrients concentration in straw (%)		
		N	P	K	N	P	K
1	Sample 1	1.01 Low	0.69 Medium	0.78 Low	1.15 Low	0.34 Low	1.03 Low
	Sample 2	0.93 Low	0.66 Medium	0.72 Low	1.06 Low	0.32 Low	0.99 Low
2	Sample 1	1.35 Low	0.47 Low	0.01 Low	1.52 Low	0.24 Low	1.16 Low
	Sample 2	1.32 Low	0.44 Low	0.99 Low	1.49 Low	0.23 Low	1.15 Low
3	Sample 1	0.66 Low	0.37 Low	0.54 Low	0.78 Low	0.25 Low	0.89 Low
	Sample 2	0.07 Low	0.37 Low	0.14 Low	0.14 Low	0.28 Low	0.66 Low
4	Sample 1	0.81 Low	0.52 Low	0.64 Low	0.94 Low	0.29 Low	0.95 Low
	Sample 2	1.51 Low	0.46 Low	0.11 Low	1.69 Low	0.28 Low	1.22 Low
5	Sample 1	1.55 Low	0.27 Low	0.14 Low	0.72 Low	0.19 Low	1.23 Low
	Sample 2	1.27 Low	0.22 Low	0.95 Low	1.42 Low	0.22 Low	1.12 Low
6	Sample 1	1.40 Low	0.22 Low	0.04 Low	1.56 Low	0.25 Low	1.17 Low
	Sample 2	1.36 Low	0.20 Low	0.01 Low	1.52 Low	0.24 Low	1.16 Low
7	Sample 1	1.45 Low	0.44 Low	0.07 Low	1.62 Low	0.17 Low	1.20 Low
	Sample 2	1.42 Low	0.32 Low	0.05 Low	1.58 Low	0.16 Low	1.18 Low
8	Sample 1	1.35 Low	0.37 Low	0.60 Low	1.51 Low	0.24 Low	1.15 Low
	Sample 2	0.97 Low	0.28 Low	0.75 Low	1.10 Low	0.23 Low	1.01 Low
9	Sample 1	1.46 Low	0.34 Low	0.08 Low	1.63 Low	0.17 Low	1.20 Low
	Sample 2	1.48 Low	0.30 Low	0.09 Low	1.65 Low	0.17 Low	1.20 Low
10	Sample 1	1.12 Low	0.43 Low	0.85 Low	1.27 Low	0.27 Low	1.07 Low
	Sample 2	1.13 Low	0.33 Low	0.86 Low	1.28 Low	0.28 Low	1.07 Low
11	Sample 1	0.79 Low	0.41 Low	0.63 Low	0.91 Low	0.28 Low	0.94 Low
	Sample 2	0.64 Low	0.46 Low	0.53 Low	0.75 Low	0.24 Low	0.88 Low
12	Sample 1	0.88 Low	0.44 Low	0.69 Low	1.01 Low	0.21 Low	0.97 Low
	Sample 2	0.73 Low	0.49 Low	0.59 Low	0.85 Low	0.16 Low	0.92 Low
13	Sample 1	1.40 Low	0.34 Low	1.04 Low	1.57 Low	0.25 Low	1.17 Low
	Sample 2	1.36 Low	0.39 Low	1.01 Low	1.53 Low	0.24 Low	1.16 Low
14	Sample 1	1.07 Low	0.41 Low	0.81 Low	1.21 Low	0.26 Low	1.05 Low
	Sample 2	0.99 Low	0.38 Low	0.76 Low	1.13 Low	0.24 Low	1.02 Low
15	Sample 1	0.74 Low	0.40 Low	0.60 Low	0.87 Low	0.17 Low	0.92 Low
	Sample 2	0.67 Low	0.37 Low	0.55 Low	0.78 Low	0.15 Low	0.89 Low

Notes:

P_2O_5 % * 0.436 = P % P % * 2.29 = P_2O_5 % K_2O % * 0.83 = K % K % * 1.2 = K_2O

%

Relationship between Ec (dS/m) and available N in the studied soils: the results relating correlation revealed that the available N (r = 0.784) were positively highly significantly correlated with EC (Table 5 & Figure 1). In addition to this, with the increase of soil EC, increase available N in soil observed, might be the reason for such kind of results; the high degree of soil salinity affects the restriction of available N in the soil.**

Relationship between Ec (dS/m) and available P in soil: the results regarding correlation and regression showed that the available P (r = 0.871) were highly significant and positive in correlation with EC. Similar, relationships of available P in coastal plain soils of {Edko region – Albehira Governorate} and {Abbis region – Alex. Governorate}, reported by (Aboukota 2012 and 2016).**

Relationship between EC (dS/m) and available K in soil: the results involving correlation revealed that the available K (r = 0.888) were highly significantly and positively correlated with EC in soils.**

Results on correlations of EC with NPK in the soils are graphically shown in Fig. (1). It gives strong positively correlation and regression of EC constant with available macronutrients such as (N- R^2 = 0.896; P- R^2 = 0.871; K- R^2 = 0.897).

Table (5): Correlation and regression between EC and macro nutrients in soil and wheat plant (seed and straw), and accuracy of statistical analysis.

Model Summary and Parameter Estimates

- **The independent variable is EC dS/m with Dependent Variable: N soil, P soil, K soil, N seed plant, P seed plant, K seed plant, N straw plant, P straw plant and K straw plant**

Equation	Model Summary				Parameter Estimates		
	R Square	F	df1	df2	Constant	b1	r
Linear N soil	0.897	8104.641	1	28	- 0.678	9.093	0.784**
Linear P soil	0.871	929.356	1	28	- 83.705	76.455	0.871**
Linear K soil	0.897	4255.623	2	27	- 5.544	10.226	0.888**
Linear N seed	0.857	620.781	1	28	27.061	0.118	0.783**
Linear P seed	0.857	620.781	1	28	0.037	0.889	0.773**
Linear K seed	0.854	1147.365	1	28	0.658	11.369	0.893**
Linear N straw	0.858	457.365	1	28	0.251	5.297	0.813**
Linear P straw	0.867	754.635	1	28	- 6.632	5.638	0.873**
Linear K straw	0.863	749.986	1	28	- 4.362	12.254	0.777**

- **The independent variable is EC dS/m.**
- **** Correlation is significant at the 0.01 level.**

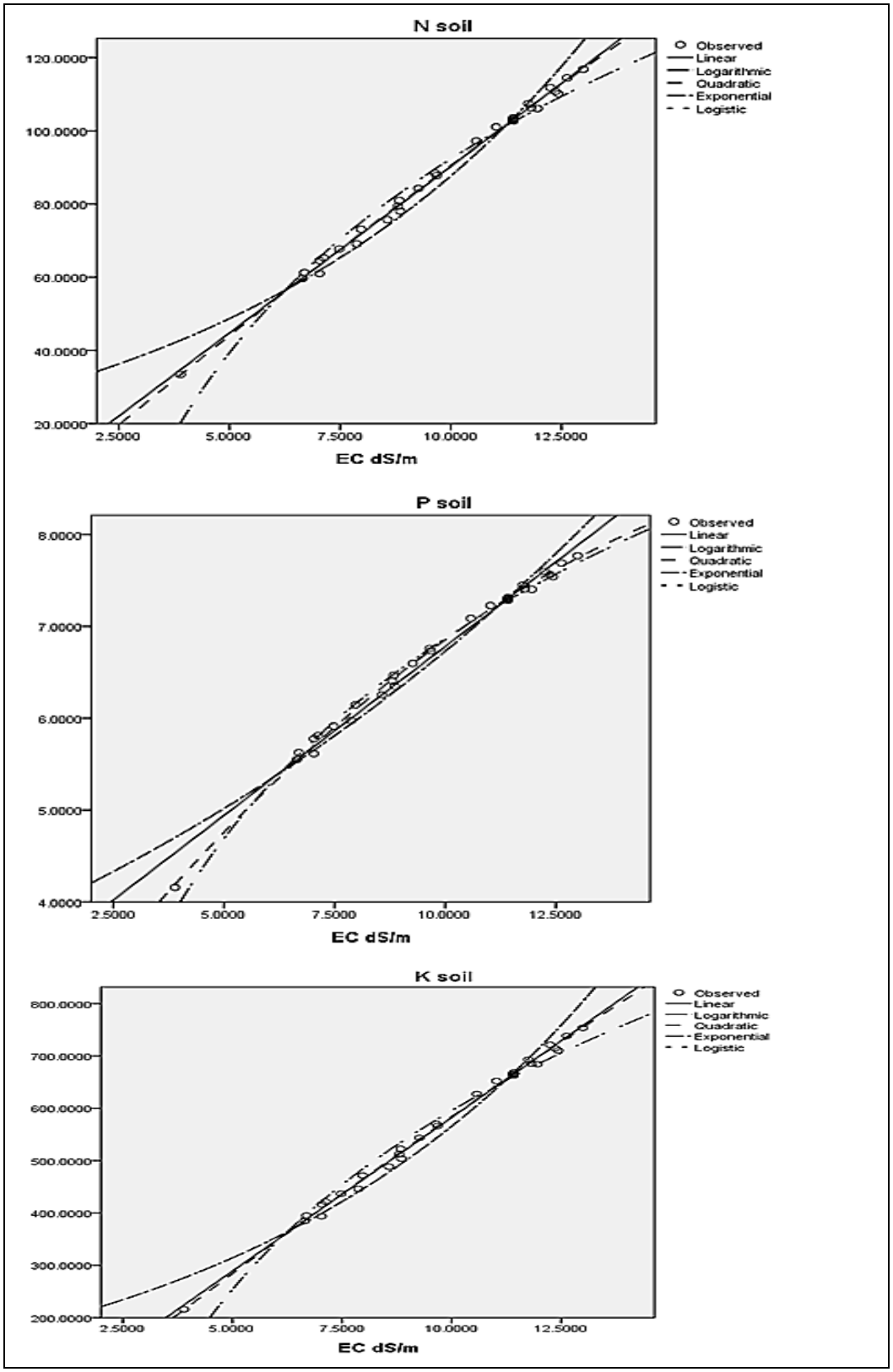


Figure (1): Relationship between Ec (dS/m) and available N, P, K mg kg^{-1} in soils.

These results clearly indicate the frequency depended of correlation coefficient of electric constant of soils with their available macronutrients.

The increase of available N with higher salinity may be ascribed to the inhibition effect of salinity on the microbial activity of nitrogen transformation in the soil and its loosing for the soil consequently promote its residual amount in the soil. The residual ammonium in the soil may be fixed with the clay mineral consequently enhanced its availability in the soil. Soil salinity is a major limitation to crops production in many areas to the world. Salinity is a wide spread environmental stress for crop plants in arid and coastal regions.

Relationship between EC (dS/m) and available N, P and K mg kg^{-1} in seeds: the results relating correlation revealed that the available N (r = 0.783), P (r = 0.773**) and K (r = 0.893**) were highly positively significantly correlated with EC (Table 5 & Figure 2). It gives strong positively correlation and regression of EC constant with available macronutrients in seeds such as (N- R^2 = 0.857; P- R^2 = 0.857; K- R^2 = 0.854). Prakash *et al*., (2010) found that height and weight of all cultivars were less affected by the salt stress, under field visit. Seed germination, seedling emergence and their survival are particularly sensitive to substrate salinity.**

The present study confirms that at all salinity levels the variation in NPK CONTENT, ionic and availability nutrition could be better explored in determining the tolerance capacity of the wheat cultivars. Relationship between Ec (dS/m) and available N, P and K mg kg^{-1} in straw: the results relating correlation revealed that the available N (r = 0.813), P (r = 0.873**) and K (r = 0.777**) were highly significantly and positively correlated with EC (Table 5 & Figure 3). It gives strong positively correlation and regression of EC constant with available macronutrients in seeds recorded as (N- R^2 = 0.858; P- R^2 = 0.867; K- R^2 = 0.863). Due to increasing salt salinity large areas of arable land are being removed from crop production every year (Chapman, 1975 and Epstein *et al*., 1980).**

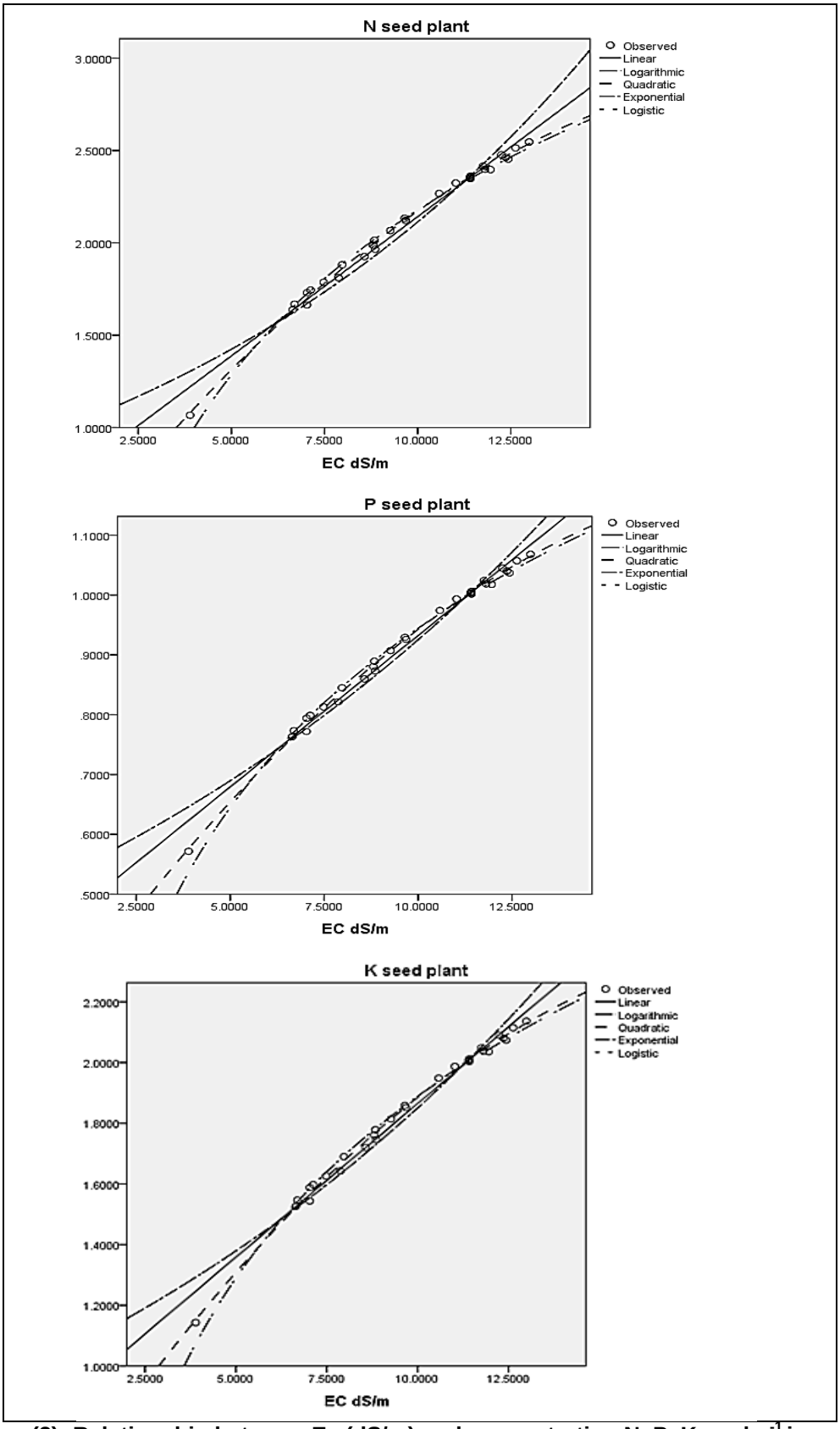


Figure (2): Relationship between Ec (dS/m) and concentration N, P, K mg kg^{-1} in seeds.

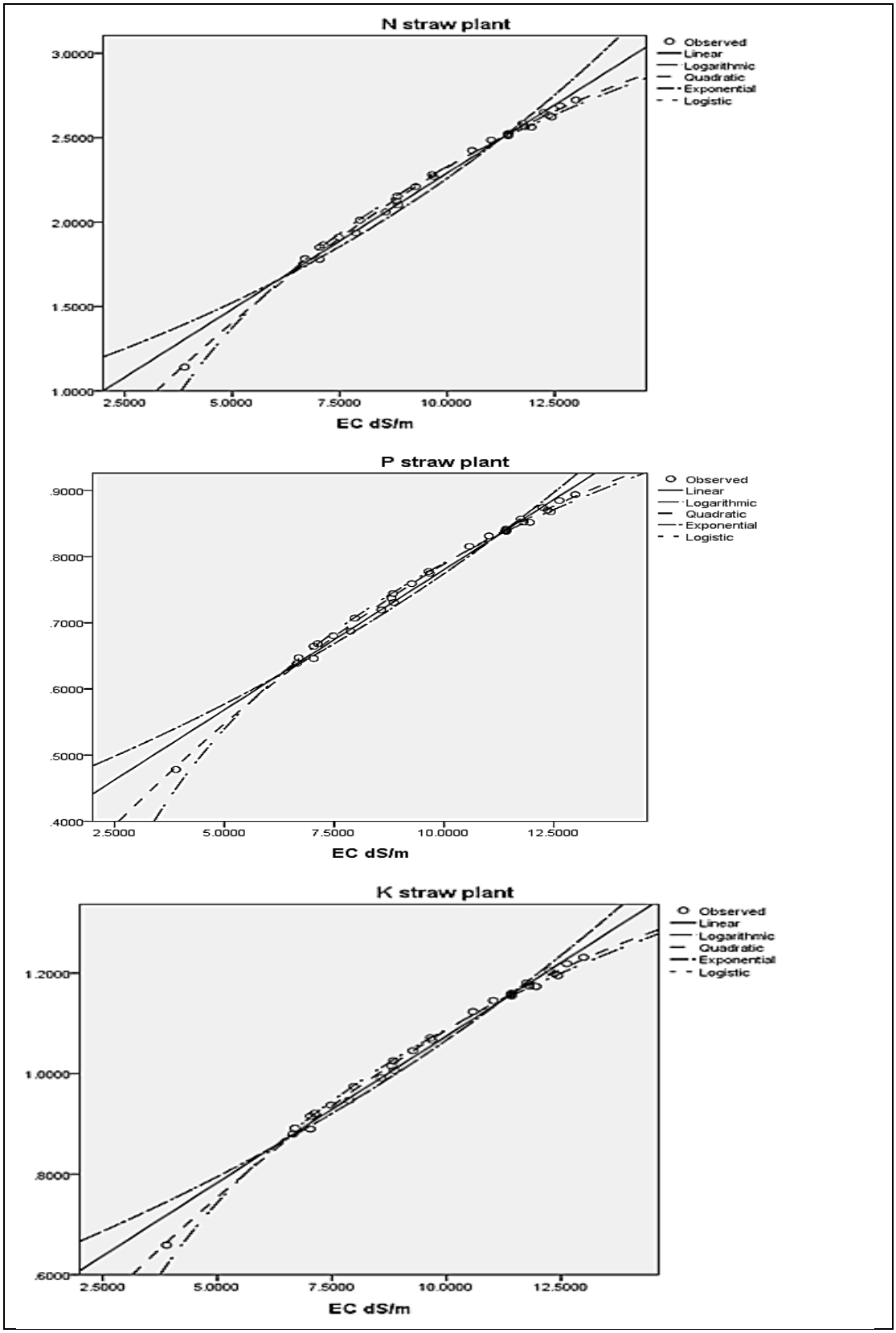


Figure (3): Relationship between Ec (dS/m) and available N, P, K mg kg^{-1} in straw.

Conclusion:

Soil salinity is a threat world-wide to agricultural production and ecosystems because it reduces plant growth and microbial functioning. The effects of salinity and soil water content on soil nutrients have been studied extensively, but usually separately, in saline soils, the water content also influences the salt concentration in the soil solution (osmotic potential), the study of interaction between soil water content and salinity on soil nutrients is needed. Further in the field, soil salinity and water content are not constant in time and space.

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تأثير ملوحة التربة علي إمتصاص المغذيات الكبري الميسرة بواسطة نبات القمح

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الملخص العربى

تعتبر ملوحة التربة في مصرهي المعوق الأساسي لتنمية القطاع الزراعي. في العقود القليلة الماضية ، وقد بذل المزارعون والحكومة جهداً كبيراً لمقاومة ملوحة التربة. تُعرف مقاومة التربة لعمليات الملوحة من خلال المجهودات الإيجابية البشرية باسم مرونة التربة. تهدف هذه الدراسة إلى تقييم ملوحة التربة ومرونتها في شمال دلتا النيل (محيط بحيرة ادكو محافظة البحيرة) وتقييم تأثيرها على امتصاص العناصر الغذائية الكبري بواسطة نبات القمح. ولتحقيق هذه الأهداف (١) أجري مسح ميداني لتحديد الخصائص الفيزيائية والكيميائية الرئيسية للتربة وحالة العناصر الغذائية في أراضي في منطقة الدراسة ، (٢) تم استكشاف آثار الملوحة على امتصاص المغذيات الكبري والعلاقات الأيونية ، و (٣) قدرت حالة المغذيات الميسرة في التربة ونبات القمح في بيئات الملوحة. وأظهرت هذه النتائج أن القوام الطيني للتربة هو السائد للاراضي المزروعة. بالإضافة إلى ذلك ، تتراوح قيم السعة التبادلية الكاتيونية CEC ما بين ٢٦,٤٩ إلى ٣٣,٠٣ $Cmolc\ kg^{-1}$ ، و $CaCO_3$ الميسرة ما بين ٠,٩١ و ٣,٠٤٪ ، وتتراوح نسبة الجبس ما بين ١,٦٩ إلى ٥,٦٤٪. وقد تميزت الكاتيونات الذائبة في مستخلص عجينة التربة المشبعة بسيادة كاتيون الصوديم يلية الكاليسوم فالماغنسيوم واخيرا البوتاسيوم. اما الانيونات الذائبة فقد تميزت بسيادة أنيون الكلوريد يلية الكبريتات. واوضحت النتائج من التحليل الاحصائي الي وجود ارتباطات ما بين EC مع المغذيات الكبري (N, P, K) في التربة ، حيث اعطي ارتباطا إيجابيا معنوي جدا وتراجع ثابت EC مع المغذيات الكبري الميسرة. كما تؤكد الدراسة أن في جميع مستويات الملوحة ، يمكن استكشاف الاختلاف في الإنبات ، ونمو النباتات ، وتراكم المواد الجافة ، والتغذية الأيونية والتوافر في البذور والقش بشكل أفضل في تحديد قدرة التحمل لأصناف القمح.

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