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Effect of Soil Salinity on Growth, Yield and Nutrient Balance of Peanut Plants

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Abstract: A field experiment was carried out at El-Tina Plain in Ismailia Governorate during summer season of 2014, to study the effect of different levels of soil salinity on the growth and yield and content of nitrogen, phosphorus and potassium and its relationship with nutrient balance of peanut plants. Soil salinity levels were 6.3, 7.6, 8.8,9.4,10.6 and 11.8dS m^{-1}. All agricultural operations were similarly in all the different areas of salinity. Plant samples were taken and the values of crop in six different areas in soil salinity. Diagnosis and Recommendation Integrated system was used to determined nutritional balance. The results indicated that increasing soil salinity decreasing straw and grain yield by 47.7 and 53.6% respectively. While grain content of oil and protein decreased by 7.84 and 12.1 % respectively. Nutrient indices showed that increasing soil salinity decreased N and P in peanut plants, while potassium was not affected. So it must be interest to N and P fertilization under saline soil conditions.
Key words: Salinity, peanut plants, Growth, Yield, Nutrient balance.

Introduction:

El Tina plain region the study area is located at the northwestern part of Sinai Peninsula, Egypt, between longitudes 32º20'35"and 32º33'10" east and latitudes 30º57'25" and 31º04'28" north, approximately 174 km^2. It is located under arid conditions; the annual rainfall ranges from 33.3 mm to 70.2 mm and occurs over a short period (from October to March).El-Tina plain is almost flat and the ground elevation ranges from 0-5m above sea level. The soils of El-Tina plain were characterized by shallow to deep soil profile underlain by water table at 50-100 cm. Soil texture varies between sandyloam to clay and soils are extremely saline [1]. Nawar[2] classified thesoils of El-Tina plain into two orders, Entisols and Aridisols, which include eight subgroups: Typic Aquisalids, Typic Haplosalids, Aquic Torriorthents, Typic Torriorthents, Aquic Torripsamments, Typic Torripsamments, Gypsic Aquisalids and Gypsic Haplosalids.

Soil salinity is the salt content in the soil; the process of increasing the salt content is known as salinization. Salts occur naturally within soils and water. Salinization can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also come about through artificial processes such as irrigation. Salinization is a worldwide problem that affects the physical and chemical properties of soil, leading to the loss of crop productivity. As salt-affected soils are common in arid and semiarid climates with precipitation rates lower than evapotranspiration rates.

The Diagnosis and Recommendation Integrated System (DRIS) relate the nutrient contents in dual ratios (N/P, P/N, N/K, K/N ……), because of the relation between two nutrients, the problem with the biomass accumulation and reduction of the nutrients concentration in plants with its age is solved[3, 4]. The use of DRIS on concept of nutritional status of plants, this method puts the limitation of nutrients in order of plant demand, enabling the nutritional balance between the nutrients in leaf sample. With the use of dual relation on DRIS, the problem with the effect of concentration or dilution on the nutrients in plants issolved[3, 5]. The disadvantage of this methodology is thatthe DRIS index is not independent, because one nutrient concentration can have hard influence on the other DRIS index for one nutrient but this problem can be corrected in parts with a hard selection of the nutrient that will compound the DRIS norms[6] .Considering that DRIS uses the nutritional balancing concept (relationship among nutrients), it is postulated that this method might be more precise than the others in the detection of nutritional deficiencies or/and excesses[7].

Therefore, the aim of the research was to study the effect of different levels of soil salinity on the growth and yield and content of nitrogen, phosphorus and potassium and its relationship with nutrient balance of peanut plants.

Materials and Methods:

A field experiment was carried out in sandy clay soil of private farm at El-Tina region in Ismailia Governorate during summer season of 2014. To identify the initial characteristics of the experimental soil, a surface soil sample (0-30cm depth) was collected before the beginning of the experiment and subjected to some physical and chemical analyses according to Jackson [8]as well as some soil essential nutrients status [9].The obtained results are presented in Table (1).

The samples of lettuce were dried at 65C°for 48 hrs, ground and wet digested using H2SO4:H2O2 method[10]. The digests samples were then subjected to measurement of N using Micro-Kjeldahle method; P was assayed using molybdenum blue method and determined byspectrophotometer[11] and Kwas determined by Flame Photometer[12].

Table (1): Some chemical properties of experimental soils:

	pH*	ECe Sat.Ext. ds/m	Anions Sat.extmeq/1.				Cations				Available nutrients (ppm)		
			Cl^-	$CO_3^=$	HCO_3	$SO_4^=$	Na^+	K^+	Ca^{++}	Mg^{++}	N	P	K
1	8.02	6.3	30	nd	3.95	26.6	39	1.30	11.50	8.8	65	3.90	222
2	8.05	7.6	42	nd	4.65	29.0	51	1.44	13.46	9.76	60	3.99	190
3	8.12	8.8	54.6	nd	3.95	29.6	58.6	1.4	15.25	12.7	75	3.57	233
4	8.00	9.4	55.0	nd	4.96	32.5	63	1.43	15.1	12.9	72	3.40	220
5	8.00	10.6	64.5	nd	4.96	32.3	71.3	1.61	15.5	13.4	77	3.61	231
6	8.10	11.8	79.5	nd	7.2	30.8	86.3	1.35	14.3	15.6	77	3.60	220

All experimental plots were irrigated by water of El-Salam Canal which characterized by the mean chemical composition recorded in Table (2)

Table (2): Some chemical properties ofEl-Salam Canal water

pH*	EC ds/m	Anions Sat.extmeq/1.				Cations			
		Cl^-	$CO_3^=$	HCO_3	$SO_4^=$	Na^+	K^+	Ca^{++}	Mg^{++}
8.20	1.90	8.4	nd	3.95	6.67	10.1	0.16	3.56	5.2

Calculation of DRIS indices:

The DRIS indices were calculated by using thefollowing index equations by Bailey *et al*[13]:-

$$\text{N- Index} = \frac{-f(P/N) - f(K/N)}{n}$$

$$\text{P-Index} = \frac{f(P/N) + f(P/K)}{n}$$

$$\text{K- Index} = \frac{f(K/N) - f(P/K)}{n}$$

where

$f(A/B) = 1000\ [(A/B)/(a/b)-1]/CV$ when $A/B > a/b$

or

$f(A/B) = 1000\ [(1- (a/b)/(A/B)]/CV$ when $a/b > A/B$

in which A/B is the value of the ratio of the two nutrients (N, P, K) in the straw of peanut, and a/b is the value of corresponding norm, n is the number of function, and CV is the coefficient of variation associated with each nutrient ratio norm. The Nutritional Balance Index (NBI) was calculated by summing the value in module of the index generated in sample. This NBI may be useful to indicate the nutritional status of the plant. The higher NBI is the greater the nutritional imbalance .[3]

Results and Discussion

Regarding the response of growth and yield, obtained data (Table, 3) indicated that increasing soil salinity levels from 6.3 to 11.8 dSm^{-1}impacted negatively on all the characteristics of growth and yield. Plant height and number of branches/plant were decreased from 33.7 to 15.7 cm and 7.5 to 3.83, respectively.This decreasing in the value of each of plant height and number of branches/plant by was by 53.4 and 48.9 %, respectively. As well as all parameters of yield decreased when soil salinity increased. While the large decline in both straw and grain, which fell from 442.9 to 231.7 and 415.2 to 192.7 kg fed^{-1}, respectively, equivalent to a decline of 47.7 and 53.6 % respectively. Memon *et al*[14]showed that plant height, fresh and dry weight of shoot and leaf area of bean plants decreased when soil salinity increased. Abdul Qados[15]indicated that under low rate of salinity, bean plants height were increased. In contrast, when soil salinity was increased; bean plants height was decreased. Previous studies have shown that the effect of encouraging low level of salinity on plant height due to low levels of salinity may induce osmotic adjustment activity in the plants which may amend growth. On the other hand, the decrease of height plant under high levels of salinity could be due to the negative effect of salinity on the rateof photosynthesis, the changes in enzyme activity and also the decrease in the concentration of carbohydrates, which can lead to inhibition of the growth[16,17].

Mensah *et al*[18]reported that under high saline conditions, peanut yield was decreased because adverse effects of salinity on water content, total dry weight, plant height and number of leaves, As well as salinity inhibits plant growth by exerting low water potentials, ion toxicity and ion imbalance. Ali *et al*[19]showed that inhibitory effect of salinity on the yield due to nutritional imbalance, which leading to reduction in photosynthetic efficiency.

Table 3: Effect of different soil salinity on growth and yield of peanut plants.

Salinity soil dSm^{-1}	Growth		Yield			
	Plant height (cm)	No. of branches/plant	Straw	Grain	Oil	Protein
			Kg fed^{-1}		%	
6.3	33.7	7.50	442.9	415.2	42.1	23.1
7.6	30.5	6.49	343.2	386.3	40.6	22.95
8.8	24.7	6.16	321.7	278.1	40.0	22.1
9.4	21.7	5.33	268.4	251.7	39.9	21.7
10.6	20.8	4.67	232.6	211.9	38.8	20.3
11.8	15.7	3.83	231.7	192.7	37.4	19.85
$LSD_{5\%}$	1.07	0.60	7.3	11.8	0.25	0.13

Regarding the response of content of nitrogen, phosphorus and potassium and its relationship with nutrient balance obtained data (Table, 4) indicated that increasingsoil salinity levels from 6.3 to 11.8 dSm^{-1}lead to decreasing on N and P content of straw, while K content of straw was increased. Nutrient indices confirmed that, it was described the decrease or increase in the nutrients contentofplant. Under high rate of soil salinity (11.8dS m^{-1}) was high shortage on N and P content, This showedthe value of eachof N and P index (-14.42 and -20.092, respectively).These decreasing in N and P content lead to decreasing in grain yield because to importance both of N and P of growth and yield of all plants. The nutritional imbalance between the three nutrients (N, P and K) led to thedecline ingrain yield of peanutdespite the increase inplantcontent and nutrient index of potassium. This attributed to under high levels of soil salinity could be K content in plants membranes increased to equal tothe excessof sodiumions. Under saline condition, N accumulation reduced in plant, due to increase chloride uptake and accumulation is mostly accompanied by a decrease in nitrate concentration of plant tissues[20]. Hirpara*et al*[21]showed that increasing K content of plant under saline conditions due to increasing Na uptake of plants.

Table 4: Effect of soil salinity on N, P and K content and nutrient indices and impact on grain yield of peanut.

Salinity soil dSm^{-1}	Nutrients content			Nutrient indices			NBI*	Grain yield kg fed^{-1}
	N	P	K	N	P	K		
6.3	2.75	0.36	1.96	-3.365	-9.707	13.072	26.14	415.2
7.6	2.72	0.34	2.00	4.147-	-10.908	15.055	30.11	386.3
8.8	2.65	0.28	2.05	-7.798	-13.336	21.134	42.27	278.1
9.4	2.60	0.26	2.06	-10.20	-17.771	27.971	55.94	251.7
10.6	2.48	0.25	2.12	-12.70	-19.539	32.239	64.48	211.9
11.8	2.45	0.22	2.12	-14.42	-20.092	34.512	69.02	192.7

* NBI = Nutrient Balance Index

Diagnosis and recommendation integrated system (DRIS) is claimed to have certain advantages over other conventional interpretation tools [22].DRIS has been used successfully to interpret the results of foliar analyses for a wide range of crops such as forage grass [23], pepper [24], peanut[25]and lettuce [26].

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