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UTILIZATION OF SALT AFFECTED SOILS FOR WHEAT-RICE PRODUCTION IN ARID REGION OF EGYPT

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ABSTRACT

A field experiment was conducted on a salt affected soil at Hussienia south plain, Sharkia Governorate, during two successive seasons winter 2008/2009 and summer 2009 to evaluate the effect of soil amendments i.e., gypsum and sulfur applied individually or combined with different nitrogen sources i.e., urea formaldehyde, urea and ammonium sulfate at three rates 75 %, 100% or 125 % N from the recommended dose for wheat plants. Rice was grown in the same plots without any further application of the aforementioned soil amendments to study their residual effects on straw and grain yields as well as uptake of N, P and K. Results showed that the soil amendments significantly improved the straw and grain yields of wheat as well as N, P and K uptake by both straw and grain compared to the control treatment. Also, it was found that straw, grain and N,P and K uptake by plants increased with increasing rates of nitrogen sources application and the highest values were achieved at a rate of 125 % N from the recommended dose. The combination between soil amendments and nitrogen sources produced higher values of straw, grain yields and N, P and K uptake values, compared to the soil amendments or nitrogen sources alone and the control. The highest values of straw and grain yields as well as N,P and K uptake by wheat plants were recorded by the combined application of urea formaldehyde at a rate of 125% from recommended dose + gypsum. Concerning the residual effect of soil amendments, the results revealed that the straw and grain yields as well as N, P and K uptake by rice plants were significantly enhanced with the application of nitrogen fertilizer combined with the residual effect of the used soil amendments. However, the higher values of the abovementioned parameters were obtained due to the residual effect of sulfur combined with nitrogen fertilizer. The soil samples analyzed after both wheat and rice harvesting showed that the residual effect of gypsum or sulfur significantly reduced the soil ECe, ESP and pH. From the results, it could be recommended that the application of 125% N from recommended dose especially in the slow release combined with soils amendments were required for wheat and rice grown on new reclaimed salt affected soils as well as reduced soil ECe, ESP and pH.

INTRODUCTION

Soils in the north east of Egypt are affected to different degrees with salinity and/or sodicity conditions that can cause difficulties in water penetration as well as nutrient relationships. These soils have long been the focus of specific management techniques to control and manage sodium (Na) problems. Sodic soils are characterized by higher content of an exchangeable sodium percentage (ESP) of 15% or more. They can also be characterized as having a Na adsorption ratio (SAR_e) from a saturated soil extract of 13 or greater. Soils high in Na are inclined to have water penetration and infiltration problems due to the dispersion of clay particles within the soil (Amezketa and Aragues, 1995). Dispersion of clay particles allows them to be transported into pore spaces that were previously available for water penetration and infiltration. Sealing of soil pores can produce a crusting problem that can inhibit seedling emergence and growth. Sodic conditions cannot be corrected with additional irrigation (leaching) applications alone. In fact, the problem may be exacerbated by applying additional water, particularly if it is high in Na. Leaching of a sodic soil can remove the divalent cations e.g. calcium (Ca^{2+}) and magnesium (Mg^{2+}), from the soil profile and root zone leaving the monovalent cation Na^+. Calcium and Mg are the primary elements that contribute to soil flocculation while Na^+ causes dispersion of a soil because of its large hydrated radius, as compared to Ca^{2+}, Mg^{2+} and potassium (K^+). The large hydrated radius of Na^+ forces the clay particles apart creating a dispersed soil condition. On the other hand, Saline soils generally are found to have an electrical conductivity (EC_e) of 4 dSm^{-1} or greater from a saturated extract. Saline conditions are generally easier to correct as compared to sodic or saline-sodic soils where leaching can be an effective treatment There are several traditional treatments used to correct sodicity problems in soils.

One approach involves the use of gypsum ($CaSO_4{\cdot}2H_2O$). Gypsum ($CaSO_4{\cdot}2H_2O$) tends to increase the levels of Ca^{2+} in the soil that can then exchange with the Na^+ creating sodium sulfate (Na_2SO_4), which can be leached from the soil.

Another common treatment of sodic soils is the addition of elemental sulfur (S). Elemental S, when oxidized by soil microbes and combined with water, reacts to form sulfuric acid (H_2SO_4), which reacts with naturally occurring calcium carbonate ($CaCO_3$), releasing "free" Ca^{2+}. This Ca^{2+} in the soil solution can then exchange for Na^+ in the form of Na_2SO_4, which can be leached from the soil. Reduction in plant growth under salt stress is usually attributed to osmotic stress due to a lowering of external water potential (Maas and Niemam 1978) or to specific ion effect on metabolic process in the cell. Availability of plant nutrients in problem soils is severely limited to sustain high production of crop, especially of nitrogen due to volatilization and denitrification losses.

Nitrogen is the mineral element that plants require in the largest amounts and is a constituent of many plant cell components, including amino and nucleic acids. Under sodic saline conditions, the mineral nutrition of most plants can expect to be detrimentally affected. Most of farmers depended on the commercial nitrogen fertilization as urea, ammonium nitrate and ammonium sulphate for obtaining higher yields of crop. These forms of nitrogen which are used under saline or saline sodic soils suffer from losses by volatilization and or leaching causing reduction in fertilizer use efficiency by different crops. Only 50% of applied nitrogen is taken up by non-legume crops such as maize and wheat and only 30-40 % by rice (Hardy *et al*.,1975). Many research reported that this low efficiency is largely due to NH_3 volatilization that is encouraged by the high pH of soil. As the nitrogenous fertilizers used contain their nitrogen as ammonical nitrogen or becomes ammonical upon hydrolysis, therefore, on problem soils, the NH_3 volatilization losses might be much higher than that of normal soils (Fan and Mackenzle, 1993). Also, Daniel, *et al*. (2006) found that nitrogen absorption is inhabited by root zone salinity , which could result in increased NO_3 leaching. Irshad *et al*. (2008) stated that all N sources i.e., urea-N, nitrate-N, 1/2 urea-N + 1/2 nitrate-N greatly stimulated maize plant growth and nutrient uptake compared with the control in salt-stressed.

The aim of this investigation is to study the effect of different nitrogen sources and rates applied individually or combined with soil amendments on wheat plants and also studying the residual effect of soil amendments on rice plants grown on salt affected soil.

MATERIALS AND METHODS

A field experiment was conducted at private farm in Hussienia south plain, Sharkia Governorate during two successive seasons (winter 2008/2009 and summer 2009) to evaluate the effect of different nitrogen sources and rates applied individually or combined with soil amendments (gypsum and sulfur) on wheat and rice plants.

Soil samples (0-15cm) were taken before the conducting of the experiment, and some physical and chemical analyses were carried out according to Richards (1954) and Jackson (1973), and the results are presented in Table (1).

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

Characteristics	Values	Characteristics	Values
Partical size distribution		**Soluble Cations and anions (meq/L)**	
Clay %	56.70	Ca^{++}	8.98
Silt %	30.30	Mg^{++}	18.5
Fine sand %	11.60	Na^{+}	65.66
Coarse sand %	1.40	K^{+}	0.88
Textural class	Clay	CO_3^{--}	----
Soil chemical properties		HCO_3^{-}	2.96
pH (1:2.5) soil water suspension	8.63	Cl^{-}	54.60
$CaCO_3$ %	4.98	SO_4^{--}	36.46
Organic matter %	0.77	Available N mg/kg soil	12.97.00
EC (ds/m)	8.60	Available P mg/kg soil	5.87
SAR %	17.71	Available K mg/kg soil	354.00
ESP %	19.86		

The field experiment was split split plot design with three replicates. Each plot was an area of (5x10m) and was bounded by buffer strips 2.5 m wide. The nitrogen fertilizers were applied in the forms of urea (46.5 % N), ammonium sulfate (20.6 %N) or ureaform (38%N) at rates 75 %, 100% or 125 % from the recommended dose (90 kg N/fed.). Urea and ammonium sulfate were applied at four equal doses i.e., 15, 30, 45 and 60 days after sowing, while ureaform was dressed in one dose during preparing the soil. Also, basal doses of 15 kg P_2O_5 /fed. and 24 kg K_2O /fed. were applied to all the plots before cultivation of both wheat and rice in the forms of superphosphate (15%P_2O_5) and potassium sulphate (48%K_2O), respectively.

Also application 10 m^3 fed^{-1} from farmyard manure. Soil amendments were applied to the cultivated plots at a rate consisting of 2.5 Mg gypsum and 0.5 Mg sulfur /fed^{-1}. Wheat as a winter crop, Sakha, 93 (*Triticum aestivum L.,*) was cultivated in November 2008. To test the residual effect of the applied soil amendments, rice, (*Oriza sativa L.,*) Giza178 was cultivated in May 2009 (as a summer crop). Rice crop received the recommended N dose i.e. 70 kg N/fed. and 75% as well as 125% of recommended dose of nitrogen fertilizer as urea. Samples of grain and straw of both wheat and rice plants were oven dried at 70 ^{0}C and prepared for the following analysis. Total nitrogen was determined using kjeldahl method as described by Bremner, (1965). Phosphorus concentration was determined by the vanadomolybdate yellow colorimetry method (Jackson, 1973).Total potassium was estimated using flame photometer model (ANA-10B). Soil samples were also collected from 0-15 cm soil depths after wheat and rice harvesting and analyzed for EC, ESP and pH. The data were analyzed using MSTAT statistical package.

RESULTS AND DISCUSSION

Straw and grain yield of wheat:

Data presented in Table (2) indicated that the straw and grain yields of wheat plants grown on the salt affected soil were significantly affected by application of either of the used soil amendments individually or combined with different rates of nitrogen sources. Data also, revealed that the highest values of straw and grain yields were recorded due to gypsum application. This finding might be attributed to the replacement of Na ions found in soil by Ca^{+2} ones found in the applied gypsum. Such a process might probably improved the soil physical condition and consequently enhanced leaching of soluble salts by drained water.

With regard to the effect of applied nitrogen sources on straw and grain yields, it can be arranged in the following descending order: ureaform >ammonium sulfate urea. The relative increase percentages for straw and grain due to additions of nitrogen sources reached to 504.60% & 375.44% for ureaform, 389.06% & 339.57% for urea and 361.23% & 209.78% for AS, respectively compared to the control treatment. These results are confirmed with that obtained by Humaira and Rafiq (2003) who reported that yield of canola plant grown under salinity was comparatively more in N amended plants whereas it was considerably decreased in plants grown under salinity without N amendment. Homaee *et al*. (2002) found that dry matter of corn and cotton decreased by increasing salinity but increased by nitrogen fertilizer.

Concerning nitrogen fertilizer levels, data revealed that increasing nitrogen level up to 125% from the recommended dose significantly increased both straw and grain yields of wheat plants, presumably due to increased leaf area index(LAI) Esmaili *et al*. (2008) found that dry weight of sorghum plants was increased due to nitrogen application and the highest values was obtained for the highest level of nitrogen fertilization. Latiri-Souki *et al*. (1998) reported that irrigation and N fertilizer application increased dry matter and grain yield production of wheat.

Table (2): Straw and grain yield (kg/fed-1.) of wheat plants grown on the salt affected soils as affected by nitrogen sources combined with soil amendments

Treatments		Straw yield (kg/fed.)					Grain (kg/fed.)				
		N-level as percentage of the recommended dose of N					N-level as percentage of the recommended dose of N				
Amendment	**N Sources**	**0**	**75**	**100**	**125**	**Mean**	**0**	**75**	**100**	**125**	**Mean**
Without amendment	**Ureaform**	267.0	1897.0	1997.0	2296.0	**1614.3**	235.0	1339.0	1391.0	1504.0	**1117.3**
	Urea	267.0	1580.0	1438.0	1641.0	**1231.5**	235.0	1152.0	1180.0	1285.0	**963.0**
	AS	267.0	1607.0	1684.0	1665.0	**1305.8**	235.0	1235.0	1334.0	1328.0	**1033.0**
	Mean	**267.0**	**1697.6**	**1706.3**	**1867.3**	**1384.5**	**235.0**	**1242.0**	**1301.6**	**1372.3**	**1037.8**
Gypsum	**Ureaform**	401.00	2171.0	2263.0	2497.0	**1833.0**	368.0	1640.0	1790.0	1995.0	**1448.2**
	Urea	401.00	1854.0	1996.0	2161.0	**1603.0**	368.0	1295.0	1375.0	1684.0	**1180.5**
	AS	401.00	1915.0	2144.0	2218.0	**1669.5**	368.0	1429.0	1553.0	1782.0	**1283.0**
	Mean	**401.00**	**1980.0**	**2134.3**	**2292.0**	**1701.8**	**368.0**	**1454.7**	**1572.7**	**1820.3**	**1303.9**
Sulfur	**Ureaform**	350.0	2014.0	2191.0	2333.0	**1722.0**	315.0	1551.0	1581.0	1864.0	**1327.8**
	Urea	350.0	1767.0	1804.0	1857.0	**1444.5**	315.0	1208.0	1223.0	1469.0	**1053.5**
	AS	350.0	1825.0	1911.0	2028.0	**1528.5**	315.0	1312.0	1472.0	1519.0	**1154.4**
	Mean	**350.0**	**1868.6**	**1968.6**	**2072.6**	**1564.8**	**315.0**	**1357.0**	**1425.3**	**1617.3**	**1178.7**
L.S.D., at .05	**A 8.15**										**12.78**
A= N-Source	**B 9.62**										**18.17**
B=Amendment	**C 11.20**										**20.93**
C= Rates	**A*B 9.15**										**17.08**
	A*C 11.21										**20.93**
	B*C 20.93										**20.93**
	A*B*C 15.85										**29.60**

Concerning the interaction between the nitrogen sources and soil amendments, the results showed a clear significant increase in both straw and grain yields. Moreover, the interaction between gypsum and nitrogen sources was more effective than that between sulfur and the some N sources. This is mainly attributed to the conditioning effect of gypsum on the soil structure and the consequent increase in soil permeability through increasing the percentage of drainable pores at the expense of the micropores. These findings are coincide with those of Thomas *et al*. (1995) who showed that wheat yield was increased by 15% due to addition of gypsum especially in fine textured soils. It is worthy to mention that the highest values of both straw and grain yields were obtained by combined effect of gypsum and ureaform. The possible reason for effectiveness of this combination is the slow release of N and consequently helping it against both volatilization and leaching and more favorable physical and chemical properties attained due to the applied gypsum.

Macronutrient uptake:-

Nitrogen:-

The results of N-uptake by wheat plants (straw and grains) under the used treatments are presented in Table 3. Data showed that application of nitrogen sources significantly affected N-uptake by both straw and grains of wheat plants compared to the control treatment. The highest values of N-uptake were obtained due to ureaform at rate of 125 % from the recommended dose of N.

Table (3): N-uptake by Straw and grain of wheat plants as affected by soil salinity and different nitrogen sources combined with amendments (kg fed-1).

Treatments		N-uptake by straw (kg fed^{-1})					N-uptake by grain (kg fed^{-1})				
		N-level as percentage of the recommended dose of N					N-level as percentage of the recommended dose of N				
Amendments	**N Sources**	**0**	**75**	**100**	**125**	**Mean**	**0**	**75**	**100**	**125**	**Mean**
Without amendment	**Ureaform**	0.16	8.49	10.46	13.10	**10.68**	5.56	22.87	27.13	37.60	**29.20**
	Urea	0.16	2.30	2.73	5.41	**3.48**	5.56	16.21	20.49	23.40	**20.03**
	AS	0.16	2.68	3.99	4.17	**3.61**	5.56	19.03	22.90	30.96	**24.30**
	Mean	**0.16**	**4.49**	**5.26**	**7.56**	**5.92**	**5.56**	**19.37**	**23.50**	**30.65**	**24.51**
Gypsum	**Ureaform**	2.21	13.12	14.53	16.15	**14.60**	10.12	46.15	48.19	60.27	**51.54**
	Urea	2.21	4.63	6.73	6.84	**6.07**	10.12	33.36	39.94	45.25	**39.52**
	AS	2.21	6.47	11.25	13.54	**10.42**	10.12	36.33	39.06	52.69	**42.69**
	Mean	**2.21**	**8.07**	**10.83**	**12.17**	**10.36**	**10.12**	**38.61**	**42.39**	**52.73**	**44.58**
Sulfur	**Ureaform**	1.27	10.37	12.83	14.21	**12.47**	8.99	31.21	34.02	45.21	**36.81**
	Urea	1.27	3.13	3.69	4.51	**3.78**	8.99	22.50	31.00	37.15	**30.22**
	AS	1.27	5.96	8.22	10.47	**8.21**	8.99	30.13	33.61	44.76	**36.17**
	Mean	**1.27**	**6.48**	**8.24**	**9.73**	**8.14**	**8.99**	**27.94**	**32.87**	**42.37**	**34.40**

L.S.D., at .05 A= N-Source B=Amendment C= Rates	**A**	**1.69**	**.051**
	B	**0.78**	**0.10**
	C	**1.36**	**0.11**
	A*B	**1.11**	**0.08**
	A*C	**1.36**	**0.11**
	B*C	**1.36**	**0.11**
	A*B*C	**1.93**	**0.15**

The interaction between N-sources and soil amendments had significantly effect on N-uptake by both straw and grains of wheat plants. The highest values of N-uptake were obtained due to applying the highest N-fertilizer rate i.e., 125 % from the recommended dose of N combined with soil amendments. This result can be attributed to the increase in nitrogen availability due to decreasing soil pH caused by application of the used soil amendments. This result is in harmony with those of Zia *et al*. (1999) who found that application of gypsum to soil may substantially improve N use efficiency for crop production by reducing nitrogen losses. El-Masry (2001) and Mahmoud *et al*. (2008) concluded that the efficiency of N fertilization can be improved through blended fertilization with Ca^{2+} nutrition under moderate saline soil conditions. It worthy to mention that ureaform combined with gypsum surpassed its effect on N-uptake by wheat plants.

Similar results were also obtained by Mohammad (1999) who observed that the use of gypsum improved nitrogen recovery by wheat plants from 25% in the absence of gypsum to 39% in the presence of gypsum.

Phosphorus:

Data presented in Table (4) showed that the effect of N sources and rates individually or combined with soil amendments on phosphorus uptake in different plant parts, were significantly affected with N fertilization.

Table (4): P-uptake by straw and grain (kg fed^{-1}) of wheat plants grown on the salt affected soils by used nitrogen sources combined with the used amendments.

Treatments		P-uptake by straw (kg fed^{-1})					P-uptake by grain (kg fed^{-1})				
		N-level as percentage of the recommended dose of N					N-level as percentage of the recommended dose of N				
Amendment	N Source	0	75%	100%	125%	Mean	0	75%	100%	125%	Mean
Without amendment	Ureaform	0.34	4.91	6.13	6..52	**4.47**	1.32	4.48	4.68	5.65	**4.03**
	Urea	0.34	2.61	3.59	4.45	**2.74**	1.32	3.03	3.18	5.39	**3.23**
	AS	0.34	4.89	6.17	6.97	**4.59**	1.32	5.48	6.67	7.37	**5.21**
	Mean	**0.34**	**4.13**	**5.29**	**5.98**	**3.93**	**1.32**	**4.33**	**4.84**	**6.13**	**4.15**
Gypsum	Ureaform	1.64	7.50	7.57	8.98	**6.67**	1.72	5.52	6.59	7.41	**5.31**
	Urea	1.64	3.59	5.38	6.14	**4.18**	1.72	4.64	4.79	6.27	**4.35**
	AS	1.64	8.65	9.87	10.67	**7.70**	1.72	8.10	10.51	11.18	**7.87**
	Mean	**1.64**	**6.58**	**7.60**	**8.59**	**6.18**	**1.72**	**6.08**	**7.29**	**8.28**	**5.84**
Sulfur	Ureaform	0.68	5.20	6.47	7.64	**4.99**	1.71	5.13	5.52	5.91	**4.56**
	Urea	0.68	2.69	4.87	5.97	**3.97**	1.71	4.12	4.19	5.72	**3.93**
	AS	0.68	6.71	8.94	9.35	**6.42**	1.71	5.87	7.61	8.61	**5.95**
	Mean	**0.68**	**4.86**	**6.76**	**7.65**	**5.12**	**1.71**	**5.04**	**5.77**	**6.74**	**4.81**

L.S.D., at .05
A= N-Source
B=Amendment
C= Rates

	Straw	Grain
A	**0.03**	**0.044**
B	**0.03**	**.051**
C	**0.031**	**0.077**
A*B	**0.04**	**0.073**
A*C	**0.063**	**0.11**
B*C	**0.044**	**0.11**
A*B*C	**0.063**	**0.15**

The highest values of P-uptake were recorded due to application of the highest N fertilizer level i.e.125% from the recommended dose of N. This might be attributed to the high capacity of plant supplied with N fertilizer in building metabolites which might contribute much to the increase in dry matter content and nutrients uptake by plants. These results stand in well agreement with those obtained by Esmaili *et al*. (2008) who found that in saline soil treatments combined with nitrogen fertilizers increased P-uptake by sorghum plants.

Furthermore, the P-uptake by both straw and grains of wheat plants when application of ureaform, urea and ammonium sulfate combined with sulfur or gypsum as soil amendments were suppressed as compared with N-fertilization in the absence of soil amendments. The highest values of P-uptake was obtained by applying ammonium sulfate combined with gypsum. This might be attributed to the effect of NH_4^+ neutral and alkaline soils on inducing rhizosphere acidification which can increase the availability of P (Logan *et al*.2000).

Table (5): K-uptake by straw and grains of wheat plants grown on the salt affected soils (kg fed^{-1}) as affected by the used nitrogen sources combined with amendments.

Treatments		K-uptake by straw(kg fed^{-1}) N-level as percentage of the recommended dose of N					K-uptake by grain (kg fed^{-1}) N-level as percentage of the recommended dose of N				
Amendment	**N Source**	**0**	**75**	**100**	**125**	**Mean**	**0**	**75**	**100**	**125**	**Mean**
Without amendment	**Ureaform**	4.11	18.15	24.64	30.25	**19.28**	2.36	13.27	15.67	21.18	**13.12**
	Urea	4.11	15.96	18.87	22.02	**15.24**	2.36	9.24	11.54	12.21	**11.09**
	AS	4.11	16.93	22.02	25.17	**17.06**	2.36	11.35	12.67	18.28	**11.17**
	Mean	**4.11**	**17.01**	**21.84**	**25.81**	**17.19**	**2.36**	**11.28**	**13.29**	**17.22**	**11.79**
Gypsum	**Ureaform**	6.22	27.18	34.02	38.53	**26.48**	3.46	18.32	22.65	29.21	**18.41**
	Urea	6.22	18.81	22.91	27.93	**18.96**	3.46	11.58	14.29	17.24	**11.64**
	AS	6.22	21.93	30.96	33.39	**23.12**	3.46	13.24	17.31	22.36	**14.09**
	Mean	**6.22**	**22.64**	**29.30**	**33.28**	**22.85**	**3.46**	**14.38**	**18.08**	**22.93**	**14.71**
Sulfur	**Ureaform**	6.01	23.39	27.85	33.06	**22.57**	2.85	15.85	18.34	20.27	**14.32**
	Urea	6.01	17.98	20.26	23.76	**17.00**	2.85	10.37	12.34	15.92	**10.37**
	AS	6.01	18.46	23.44	27.55	**18.85**	2.85	12.57	15.67	19.21	**12.57**
	Mean	**6.01**	**19.94**	**23.85**	**28.12**	**19.47**	**2.85**	**12.93**	**15.45**	**18.46**	**12.42**

L.S.D. at 0.05 A= N-Source B=Amendment C= Rates

A 0.750 0.810
B 0.740 0.670
C 1.110 0.82
A*B 1.060 0.950
A*C 1.160 1.560
B*C 1.160 1.560
A*B*C 1.630 2.210

Potassium:

Results in Table (5) demonstrate the effect of nitrogen sources and rates on K-uptake by straw and grains of wheat plants. Data showed a significant response of K-uptake due to applying the used nitrogen sources and levels. The increases in K-uptake by straw and grains as a result of the used nitrogen sources and rates i.e., 75, 100 and 125% from the recommended dose of N were 313.86 and 377.96, 431.38 and 463.30 and 527.98 and 629.66 % as compared to the control treatment, respectively. This result was probably caused due to a potential increase in the root exchange capacity as a result of the aforementioned treatments .

The highest K-uptake by both straw and grains (30.25 and 21.18 kg fed^{-1}) were recorded due to ureaform application at the rate of 125% from recommended dose of N., nitrogen losses when fertilizer was applied in ureaform was least because ureaform is a slow-release fertilizer and higher nitrogen uptake in ureaform treatment promoted more growth of wheat plants, and thus stimulated more K-uptake and other elements to meet the growth requirement. Yasin (1991) found that N fertilization generally increased K uptake and decreased Na concentration in leaves of wheat.

The data in Table (5) indicated that soil amendments combined with different nitrogen sources and rates induced higher K-uptake by straw and grains compared with the nitrogen sources application without soil amendments. The highest values of K-uptake by both straw and grains were recorded from the interaction treatment between gypsum and ureaform at the highest rate of N. This finding stand in well agreement with that of Salem (2003) who showed that application of soil amendments (FYM, Sulfur and gypsum) on sodic soil caused a positive effect on N, P and K concentrations in maize, clover and cotton plants compared with the control.

Residual effect of soil amendments individual or combined with nitrogen as urea on rice crop Straw and grain yields of rice and their N, P and K uptake:

Data in Table (6) represent the residual effect of soil amendments (gypsum or sulfur) combined with nitrogen fertilizer at different rates on straw and grain yield as well as N, P and K uptake. Data revealed that the residual effect of soil amendments (gypsum or sulfur) significantly increased the yields of straw and grain yields of rice plants compared to the control treatments. These results are harmony with those of Rahmatullah *et al*. (2006) who found that the residual effect of gypsum increased the rice yield by 46.4% over the control treatment. However, the residual effect of sulfur was higher than that of gypsum on straw and grain yields compared with the residual gypsum. The relative increases in straw and grain yields were 866.56% & 140.40 %, 930.39% & 180.30% and 993.61% & 216.02 % owing to the rates of 75, 100 and 125 % from the recommended dose of N, respectively. As for, the interaction between nitrogen fertilizer combined with soil amendments, the data indicated that the greatest values of straw and grain yields were detected at the treatment 125% from recommended dose of nitrogen fertilizer in the presence of the residual effect of sulfur.

T6

N, P and K uptake by rice plants:

The effect of different rates of nitrogen fertilizer on N, P and K uptake by rice plants grown on the salt affected soils are presented in Table (6). Nitrogen, P and K uptake values by rice plants (straw and grains) significantly increased and the increases were more pronounced with the highest rate of the applied nitrogen fertilizer. The relative increases in N, P and K-uptake by straw and grains of rice plants due to the highest rate of applied nitrogen were 368.45% &308.46%, 101.92% & 128.49% and 111.10% & 181.95%, for 75, 100 and 125% from the recommended dose of N respectively compared to the control treatment. Jose-Gerardo *et al*. (2007) found that sulfur application to an alkaline soil increased the solubilization of anions and cations and enhanced their availability, also decreased the soil pH in comparison with soils without sulfur application. Data also in Table (6) showed that the N, P and K-uptake by both straw and grains were significantly affected by the interaction between the residual effect of soil amendments (gypsum or sulfur) and nitrogen fertilizer. Data clear that the uptake values of N, P and K by straw and grains were higher upon using nitrogen fertilizer combined with the residual effect of sulfur than with the residual effect of gypsum. These results are in agreement with those of Khan *et al*. (2007) who reported that the nutrient uptake by sunflower was strikingly increased by the application of sulfur compared with gypsum. Elrashidi *et al*. (2010) found that addition of gypsum increased the solubility of N, K, Ca, Mg, Mn and S, whereas it decreased the solubility of P, Na, Fe, Cu, Zn and B. Yadav and Chhip (2007) found that addition of gypsum at 50 % GR recorded significant increases in available N, P, K, S and Fe contents of soil as well as the grain and straw yields of wheat over the control.

Effect of different soil amendments on EC, pH and ESP values:

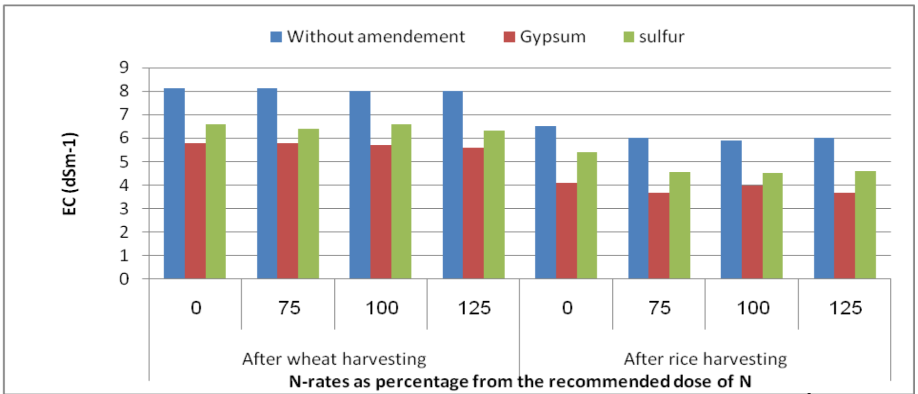

Fig. (1): Effect of different soil amendments on EC (dSm^{-1}) of the studied soil.

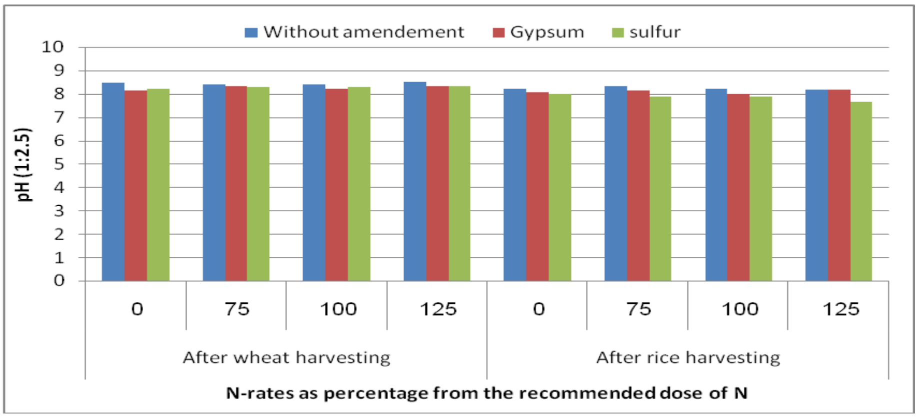

Fig. (2): Effect of different soil amendments on pH (1:2.5) of the studied soil.

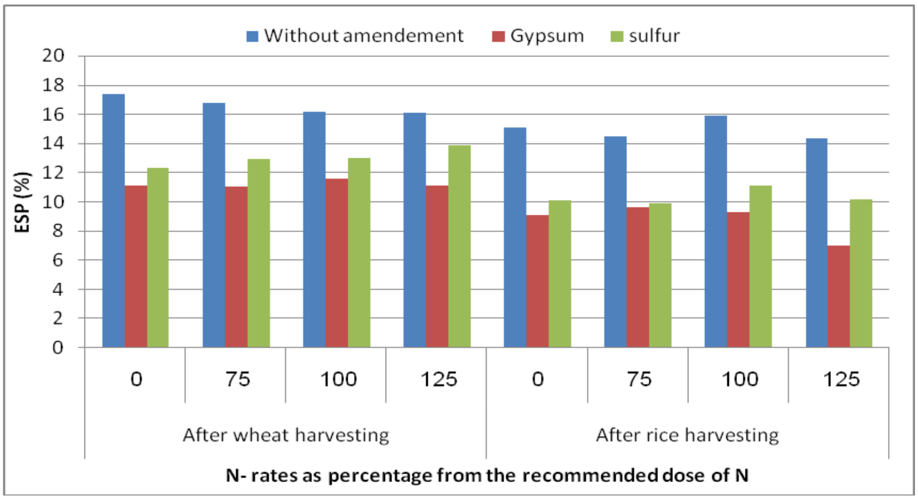

Fig. (3): Effect of different soil amendments on ESP (%) of the studied soil.

Fig. (1) demonstrated the effect of soil amendments application on EC_e of the salt affected soil after harvesting of both wheat and rice. The Fig. (1) showed that soil amendments i.e., gypsum or sulfur cause decrease in the EC_e value of soil compared to the control treatment (without application of soil amendments), while, the application of gypsum was more affective reduction in the value of EC_e than that sulfer. Also, the EC_e reduction after rice harvesting was higher than that after wheat harvesting. Because salinity build-up after rice harvesting would be less than those after harvesting of wheat. This may be attributed to the improvement of soil porosity by application of Ca^{+2} which replaced on the Na^+ on the clay mineral as well as the down movement of irrigation water which enhanced the leaching of soluble Na^+ from the soil. Barros *et al*. (2004) reported that application of gypsum was efficient for combating soil sodicity, as indicated by a positive effect on the physical and chemical characteristics of the soils. Naseem (2006) found that salt affected soils can efficiently and economically be reclaimed with the application of gypsum and compost and these treatments improved the soil parameters such as ECe, pH and SAR.

The obtained data in Fig. (2) indicates also, that application of different soil amendments caused an appreciated reduction in the pH compared to the control treatment after both wheat and rice harvest. It is clear that sulfur application was more pronounced effect on pH value of salt affected soil after rice harvest compared to the gypsum application. Jose-Gerardo *et al*. (2007) found that sulfur application in an alkaline soil increased the solubilization of anions and cations which leached and decreased the pH in comparison with soils without sulfur application.

Fig. (3) illustrated those values of ESP due to the applied different soil amendments to the soil was lower compared to the control treatment after both wheat and rice harvest. The highest decreases in ESP values after rice harvested attained due to application of gypsum than that sulfur.

Conclusion

This study confirms the important of soil amendments combined with nitrogen fertilizers on increasing the yields of straw and grains of wheat as well as their uptake of N, P and K in the salt-affected soils. Also, the residual effect of both soil amendments was extended to subsequent crop production i.e., rice and its contents of N, P and K. Soil amendments application caused also, improvement of some chemical properties such as EC_e, pH and ESP after both wheat and rice harvesting.

REFERENCES

Amezketa, E. and R. Aragues (1995). Hydraulic conductivity, dispersion, and osmotic explosion I 261.Arid-zone soils leached with electrolyte solutions. Soil Sci. 159:287-293.

Barros M.F.C., M.P.F. Fontes, V.V.H. Alvarez and H.A. Ruiz (2004). Reclamation of salt-affected soils in Northeast Brazil with application of mined gypsum and limestone. Revista Brasileira de Engenharia Agricola e Ambiental, 8(1): 59-64.

Bremner, J.M. (1965).Total nitrogen. In:I methods of soil analysis. II chemical and microbiological properties. (eds C.A. Black, D.D. Evans, J.L./ white, L.E Ensminger, F.E Clerk and R.C. Dinauer) agronomy monograph, 9, American Society of Agronomy Madison, Wisconson U.S.A.

Daniel, C. B., G.R. Cramer and D. A. Devitt (2006) Effect of salinity and nitrogen status on nitrogen uptake by tall fescue turf. Journal of Plant Nutrition, 29:1481-1490.

El-Masry, A.E.Y. (2001). Effect of some soil amendments and fertilizer application pratices on the yield of some crops under salt affected soils.Ph.D.Thesis, Al-Azhar Univ., Egypt.

Elrashidi, M. A., West, L. T., Seybold, C. A., Benham, E. C., Schoeneberger, P. J. and F. Richard (2010). Effects of gypsum addition on solubility of nutrients in soil amended with peat. Soil Science, Vol. 175-issue 4 : 162-172.

Esmaili, E., S.A. Kapourchal, M. J. Malakouti and M. Homaee (2008). Interactive effect of salinity and two nitrogen fertilizers on growth and composition of sorghum. Plant Soil Environ., 54 : 537-546.

Fan, M.X. and A.F. Mackenzle (1993). Urea and phosphate interactions in fertilizer microsites . Ammonia volatilization and pH changes, Soil Sci, Soc. Am. J., 57: 839-845.

Hardy, R.W.F., P. Filner and R.H. Hageman (1975) Nitrogen Input. In Crop Productivity-Research Imperatives, Eds.A.W.A. Brown, T.C. Hyerly, M.Gibbs and A, San Pietro. PP:133-176. Michigen State University,Agri.Expt. Sta. East Lansing, USA.

Homaee, M., R. A. Feddes and C. Dirksen (2002). A macro-scopic water extraction model for nonuniform transient salinity and water stress. Soil Sci. Soc. Am. J., 66: 1764-1772.

Humaira, G. and A. Rafiq (2003). Effect of nitrogen fertilizer on growth of canola (Brassica napus L.) under saline water irrigation. Pak. J. Bot., 35 (5) : 895-909.

Irshad, M.; A.E. Eneji and H. Yasuda (2008). Comparative effect of nitrogen sources on maize under saline and non –saline conditions. Journal of Agronomy and Crop Science, 194, 256-262.

Jackson M.L. (1973). "Soil Chemical Analysis". Prentice Hall Inc., Englewood Cliffs.

José Gerardo, Ló. A., J. F. Larios, J. M. Ochoa, S. A. Espinosa, M. R. Bello and M. G. Ramirez (2007). Salt leaching process in an alkaline soil treated with elemental sulfur under dry tropic conditions. World Journal of Agricultural Sciences 3 (3): 356-362.

Khan, M.J., M.H. Khan, R.A. Khattak and M.T. Jan (2007). Response of sunflower to different levels of sulfur. Communications in Soil Science and Plant Analysis 37: 41-51.

Latiri-Souki, K., S. Noitclitt and D. W. Lawlor (1998). Nitrogen fertilizer can increase dry matter, grain production and radiation and water use efficiency for durum wheat under semi-arid conditions. Europian j. agronomy 9 :21-24

Logan, KAB., R.J. Thomas and J.A.Raven (2000). Effect of ammonium and phosphorus supply on H^+ production in gel by two tropical forage grasses. J. Plant Nutr. 23: 41-54.

Maas, V and R.H.Niemam (1978), Physiology of land tolerance to salinity. In G.A. Yung, Ed. Crop Tolerance to Suboptimal Land Conditions. Amerian Socity of Agronomy Special Publication. Crop Science Society of America. Madison, 277-299.

Mahmoud, I. A., A. Shahzad, M. Arshadullah, A. Ali and B. Zaman (2008). Role of calcium in improving N efficiency applied to sunflower under different types of naturally salt affected soils. Soil & Environ., 27 (1) : 106-111.

Nassem, A.R. (2006). National coordinated project on management of salt affected soils and brakish water in Pakistan. Achievements of Agricultural Linkages Program.ALP Secretariat, Directorate of Planning PARC,Islamabad, : 95-96.

Mohammad, A. (1999). Nitrogen nutrition management and fertilizer use efficiency in wheat under different soil conditions. Biological Sciences, 167:170.

Rahmatullah, K., A. R. Gurmant, M. S. Khan and A. H. Gurmani (2006). Effect of gypsum application on rice yield under wheat rice system. International Journal of Agriculture & Biology 4:535–538.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkaline soils. USDA Handbook 60, Washington.

Salem, F. S. (2003). Effect of some soil amendments on the clayey soil properties and some crops production. Minufiya J. Agric. Res., 28, No.5(2): 1705-1715.

Thomas, G.A. ; G. Gibson ; R.G.H. Nielsen; W.D. Martin and B.J. Radford (1995). Effect of tillage, stubble , gypsum and nitrogen fertilizer on cereal cropping on a red-brown earth in southwest Queensland. Aust. J. Exp. Agric., 35:997-1008.

Yadav, K.K. and B.R. chhip (2007). Effect of FYM, gypsum and iron pyrites on fertility status of soil and yield of wheat irrigated with high RSC water. Journal of the Indian Society of Soil Science, Vol. 55, 638-640.

Yasin, M. (1991). Interactive effect of sodicity and nitrogen on yield and chemical composition of two wheat varieties. Pak. J. Soil Sci., 6:-1-2, 9-12.

Zia, M. S., M. Aslam, H. Rahmatullah, M. Arshad and T. Ahmed (1999). Ammonia volatilization from nitrogen fertilizers with and without gypsum. Soil use and management, 15: 133-135.

الاستفاده من الأراضي المتأثرة بالأملاح لانتاج محصول القمح و الأرز فى المناطق الجافه

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معهد بحوث الاراضى و المياه و البيئه-مركز البحوث الزراعيه-الجيزه

أجريت تجربه حقليه فى أرض متاثره بالأملاح بمنطقة جنوب سهل الحسينيه محافظه الشرقيه و ذلك خلال الموسم الشتوى (2009/2008) و الصيفى 2009 و ذلك لتقييم تاثير اضافة نوعين من محسنات التربه وهما الجبس او الكبريت منفردين او بمصاحبه صور مختلفه للنيتروجين وهى اليوريا فورمالدهيد و اليوريا و سلفات الامونيوم بالمعدلات 75و100و 125 % نيتروجين من الجرعه الموصى بها لمحصول القمح (محصول شتوى) , ثم تم زراعة الارز(محصول صيفى) فى نفس القطع السابقة المذكوره سلفا و ذلك لدراسة الاثر المتبقى لمحسنات التربه وذلك من خلال تقدير محصول القش و الحبوب و الممتص من النيتروجين و الفوسفور و البوتاسيوم بواسطة كل من القمح و الأرز.

وقد اظهرت النتائج ما يلي:-

ادى اضافة محسنات التربه منفرده او بمصاحبه صور النيتروجين المختلفة الى زياده فى محصول كل من القش و الحبوب وأيضا امتصاصهما من النيتروجين و الفوسفور و البوتاسيوم بواسطة القمح عند مقارنتها بالكنترول.

أظهرت معاملة اضافة الجبس مع المعدل العالى من النيتروجين و هو 125% من الجرعه الموصى بها فى صورة يوريافورمالدهيد اعلى زياده من محصول كل من القش و الحبوب لمحصول القمح و كذلك الممتص من النيتروجين و الفوسفور و البوتاسيوم بواسطة القش و الحبوب وذلك مقارنة بالمعاملات الاخرى.

أظهرت النتائج ان محصول الارز النامى فى نفس قطع التجربه السابقه و الذى درس من خلاله الاثر المتبقى للجبس و الكبريت على زياده فى كل من القش و الحبوب و ايضا الممتص من النيتروجين و الفوسفور و البوتاسيوم مقارنة بالكنترول.

أيضا أظهرت نتائج تحليل التربه بعد محصول القمح و الارز ان هناك انخفاض فى قيم كلامن التوصيل الكهربى ونسبة الصوديوم المتبادل و رقم حموضة التربة نتيجة اضافة كل من محسنات التربه (الجبس و الكبريت) مقارنة بالكنترول.

و لذلك يمكن التوصيه بأنه تحت مثل هذه الظروف انه يمكن اضافة محسنات التربه (الجبس و الكبريت) بمصاحبة النيتروجين و بمعدل 125% من الجرعه الموصى بها خاصة من الاسمده بطيئة الذوبان وذلك للاراضى المتاثره بالاملاح لكى نحصل على محصول عالى من كل من القمح يليه محصول الارز نتيجة للاثر المتبقى لهذه المحسنات و كذلك حدوث تحسن فى بعض خواص هذه الارض من انخفاض فى التوصيل الكهربى ونسبة الصوديوم المدمص و رقم حموضة التربة.

قام بتحكيم البحث

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Table (6): Effect of different rates of nitrogen combined with the residual effect of soil amendments on straw and grain yield, N, P and K uptake by rice plants (kg/fed.).

Treatment		Yield of Rice (kg fed^{-1})											
		Straw						Grain					
		N-level as percentage of the recommended dose of N						N-level as percentage of the recommended dose of N					
Amendment	N	0	75%	100%	125%	Mean	L.S.D. at 0.05	0	75%	100%	125%	Mean	L.S.D. at .05
		Dry weight (kg fed^{-1})											
Without amendment	Urea	329.0	3180.0	3390.0	3598.0	**2624.25**	A=180.3 B=219.8 A*B=312.3	599.0	1440.0	1679.0	1893.0	**1477.7**	A=3.25 B=3.98 A*B=5.63
Gypsum		520.0	4215.0	4338.0	4525.0	**3399.50**		880.0	2037.0	2112.0	2292.0	**1880.3**	
Sulfur		856.0	4320.0	4540.0	4680.0	**3599.00**		1039.0	2060.0	2320.0	2460.0	**2019.8**	
		N-uptake (kg fed^{-1})											
Without amendment	Urea	2.98	10.36	12.31	13.96	**9.90**	A=2.91 B=3.57 A*B=5.04	4.49	12.92	14.52	18.34	**12.56**	A=3.15 B=3.87 A*B=5.47
Gypsum		5.32	11.30	12.59	15.36	**11.14**		5.04	12.99	15.58	19.99	**13.40**	
Surfer		6.96	14.32	15.41	17.64	**13.58**		6.92	14.67	17.07	22.37	**15.25**	
		P-uptake (kg fed^{-1})											
Without amendment	Urea	0.123	0.691	0.884	0.914	**0.653**	A=0.46 B=0.56 A*B=0.80	1.295	1.956	2.149	2.967	**2.091**	A=.092 B=0.11 A*B=0.16
Gypsum		0.179	1.055	1.212	1.201	**0.911**		1.893	2.198	2.995	3.752	**2.709**	
Sulfur		0.348	2.349	4.158	4.380	**2.808**		3.428	3.925	4.618	5.110	**4.270**	
		K-uptake (kg fed^{-1})											
Without amendment	Urea	12.97	19.34	23.54	27.38	**20.80**	A=0.92 B=1.13 A*B=1.61	4.49	8.46	11.62	12.66	**9.31**	A=1.03 B=1.26 A*B=1.79
Gypsum		20.2	23.34	26.81	30.47	**25.20**		5.56	14.36	15.27	18.31	**13.37**	
Sulfur		22.72	24.47	30.73	33.21	**27.78**		7.67	16.27	14.27	22.55	**15.19**	

A= amendment
B=rate