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IMPROVING THE QUANTITY AND QUALITY OF WHEAT IN SALT AFFECTED SOILS

Nassar, K.E.M.; M.M. El-Shouny and E.M.K. Behiry
Soils, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt.

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ABSTRACT: In salt affected soil, wheat plants suffer from many problems related to soil salinity and alkalinity which affected the wheat productivity and retard the availability of nutrients in soil and their uptake by plant. The present investigation aimed to raise the productivity of wheat plants grown under the previous condition and investigate the possibility of the partial replacement of N-fertilization along with improving the poor physical, chemical and biological soil characteristics by the application of some soil amendments. Therefore, two field experiments were carried out at Sids Agric. Res. Station, Agric. Res. Center during the two winter seasons 2002/2003 and 2003/2004. The amendments were added at levels of 20 m^3/fed., for farmyard manure as well as 1 and 5 ton/fed. for sulphur and gypsum, respectively. N-fertilization was applied at 37.5 and 75 kg N/fed. In addition, Zn, Mn, Fe and Cu were added in the EDTA form at rates of 0.3 g/L for Zn, Mn and Fe and 0.15 g/L for Cu.

The obtained results clearly showed that:

1-Wheat grain and straw yields as well as their NPK contents and grain protein content significantly responded to the application of soil amendments. In this concern, chemical amendments (sulphur and gypsum) recorded higher values than those attained with the application of farmyard manure. Yet, sulphur gave the highest values for all previous parameters compared with the other amendments.

2-For obtain the highest economic grain and straw yields, it must fertilize the soil with the optimum rate of N, i.e. 75 kg N/fed.

3-N-fertilization was the most effective factor compared with the soil amendments and foliar spraying of micronutrients concerning its effect on wheat quantity and quality.

4-Application of soil amendments and foliar spraying of micronutrients promote the use efficiency of N-fertilization. This significantly reflected on grain and straw yields and gave the better nutritive content than the control plants received the recommended dose of N and did not reclaim or spray with micronutrients. In this concern, the addition of 1 ton S + 75 kg N/fed. + 0.3 g Zn/L gave the highest increments of yield quantity and quality parameters, whereas, the application of farmyard manure at the same previous rate of N-fertilization scored the least increments.

5-The application of all soil amendments decreased soil pH. Elemental S had the superiority effect followed by gypsum and farmyard manure in a descending order. However, marked decreases in both soluble and exchangeable sodium as well as significant increases in soluble and exchangeable calcium were observed by the addition of all amendments. In this respect, gypsum gave the highest values compared with the other amendments .

Therefore, it could be concluded that the application of 1 ton S+ 75 kg N/fed. + 0.3 g Zn/L in the EDTA form (400 L/fed.) is the best formula for the wheat plants under the condition of salt affected soils for achieving the best wheat crop, improving its nutritive content and raising grain protein content.

Key words:Nitrogen fertilization, Wheat plant, Salt affected soils, Amendments, Micronutrients.

INTRODUCTION

Wheat is considered the first produced cereal, but its cultivated area produces only about 30% of the domestic needs. To overcome this problem, attention has been paid to improve the quantity and quality of total production through improving the soil properties, good management of soil fertilization and foliar spraying of micronutrients.

Considerable and long lasting effects have been recognized in Egyptian agriculture as a result of the shifting of soil pH towards alkalinity that affects the equilibra and availability of nutrients in the soil especially phosphorus and micronutrients. So, some plant disorders are already arised. Hence, serious steps at permanent and adequate use of bio- and chemo-corrective additive should be planned to bridge the gap of nutrients unavailability and solve the problems relating to soil degradation those reflect on the resultant crops. In this concern, many researchers advice the using of chemical amendments such as gypsum and sulphur as well as organic farmyard manure as sake of improving the poor physical, chemical and nutritional properties of the deleterious soils (Khader- Saffaa, 1998; El-Masry, 2001 and Salem, 2003). Successful reclaimation should aim to replace exchangeable Na^+ by Ca^{2+} when leaching process takes place. Then, some decreases in pH and EC of soil occurred to become suitable for nutrient availability and uptake.

Nitrogen is one of the major nutrients for various plants especially wheat and other cereals as sake of producing the economic yield. Its essential role may be attributed to one or all of these reasons:

1- N is constituent of all proteins and nucleic acids and hence of all protoplasm, Russell (1973).

2- N enhances the meristematic activities consequently, increaseing the cell size that manifested in internode elongation, (Sabry *et al.*,1999 and Osman *et al.*, 2000).

3- N increases the nutrients uptake, capacity of photosynthesis assimilation in building metabolits, its translocation and accumulation in the sink (El-Masry, 2001 and Fathi *et al.* 2003).

Wheat is one of the crops that are highly responsive to the addition of micronutrients. El-Masry (2001) and Nassar *et al.* (2002) attributed the promoting impacts of micronutrients to their capability to enable the plants to grow well and improve transferring the photosynthetic substances from leaves to grains during the synthesis process because of their effects on enzymatic group consequently, the weight of grains increases.

Therefore, the present investigation was undertaken to study the possibility of the partial replacement of mineral nitrogen fertilization along with improving the poor soil physical, chemical and biological characteristics by the application of some soil amendments and supplying the plants with their micronutrients requirements. The comparisons between the effects of soil amendments, micronutrients and their interactions under the two levels of N-fertilization on the wheat grain and straw yields as well as their chemical compositions were also taken into consideration.

MATERIALS AND METHODS

Two field experiments were conducted at Sids Agric. Res. Station, Beni Sowif governorate during 2002/2003 and 2003/2004 growing seasons. Representative soil samples (0-30 cm) were taken before performance of the experiments. Some soil physical and chemical analyses were performed according to Richards (1954) and Jackson (1973), respectively and presented in Table (1). Gypsum and sulphur requirements were also determined according to Schoon-over's equation as recorded by Richards (1954).

Each experiment included thirty treatments which were the combinations of three soil amendments, two levels of N-fertilization and five types of micronutrients. The layout of the experiments was split-split plot design with three replicates. Each replicate was divided into three main plots. The first and second ones were treated with 1 and 5 ton/fed, for sulphur and gypsum, respectively. However, the third main plot was treated with farmyard manure at 20 m^3/fed. Each plot was randomly subdivided into two subplots. The first subplot was fertilized with 37.5 kg N/fed. but the other one was fertilized with 75 kg N/fed. The investigated micronutrients, i.e. Zn, Fe, Mn, Cu and their mixture were foliar sprayed as EDTA form at 0.3 g/L for Zn, Fe and Mn and 0.15 g/L for Cu and randomly distributed inside each subplot as sub sub plots. Control treatment received 75 kg N/fed. and didn't receive any soil or foliar treatments. Basic application of 15 kg P_2O_5/fed. was applied to all plots in the form of single superphosphate (15% P_2O_5). The other usual cultural processes of wheat plants were practiced. The wheat grains variety "Sids 1" at a rate of 60 kg/fed. were drilled in rows of 15 cm apart within plots of 3 x 3.5 m on 25th and 28th November for the 1st and 2nd seasons, respectively.

At harvesting, a sample of 20 plants from every plot were randomly chosen to determine some yield attributes namely number of spikes/m^2, number of spikelets/spike, grain weight/spike and 1000 grain weight. However, grain and straw yields were recorded on plot basis. Then, the corresponding values per feddan were estimated as ardab and ton/fed. for grain and straw yields, respectively. N, P and K percentage of both wheat grains and straw were determined in wet digested extract using the methods described by Chapman and Pratt (1961). Crude protein in grains (kg/fed.) was determined by multiplying the values of N-content in grains (kg/fed.) by 5.7, according to A.O.A.C. (1980).

Data obtained were statistically analyzed using the combined analysis of the two growing seasons, according to Gomez and Gomez (1984). The significant differences among the means were tested using the least significant difference (L.S.D.) at the 5% level of significance.

Table (1): Mechanical and chemical characteristics of the soils under investigation:

(a) Mechanical analysis .

Season	Total $CaCO_3$ (%)	Organic matter (%)	Particle size distribution (%)				Texture class
			Coarse sand	Fine sand	Silt	Clay	
2002/2003	2.6	1.70	0.8	17.3	27.0	54.9	Clayey
2003/2004	3.1	1.82	1.6	15.5	18.9	64.0	Clayey

(b) Chemical analysis .

Season	pH (1:2.5 susp.)	EC (dSm^{-1})	Soluble ions in soil paste extract (m.e./L)								Exchangeable cations (m.e./L)				ESP (%)	CEC (m.e./ 100g soil)	Available nutrients (μgg^{-1})		
			Anions				Cations												
			CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+	Ca^{2+}	Mg^{2+}	Na^+	K^+			N	P	K
2002/2003	8.5	4.4	--	3.0	25.1	15.9	7.6	5.5	30.3	0.6	11.6	9.6	7.4	1.4	24.7	30	30.0	8.0	520
2003/2004	8.6	4.6	--	2.5	26.6	16.9	10.6	11.5	22.8	1.1	9.7	10.7	7.3	1.3	25.2	29	31.0	8.5	560

RESULTS AND DISCUSSION

The present study is mainly aimed to decrease the N-fertilization for wheat plants grown under saline sodic soils conditions through improving their physical, chemical and biological characteristics. It was achieved herein, by the application of some soil amendments and foliar spraying of some micronutrients. So, data attained included the influence of the investigated soil amendments, N-fertilization rates, foliar spraying of micronutrients and their possible interactions on the wheat grain and straw yields as well as some mineral contents.

1-Effect of soil amendments:

Data obtained in Table (2) revealed that the application of soil amendments led to insignificant response for the number of spikes/m^2 and significant increases in number of spikelets and grain weight/spike as well as 1000 grain weight.

The enhancing impacts of soil amendments on the yield attributes reflected on both grain and straw yields/ fed., where there were positive relationships between both grain and straw yields and soil reclaimation with the investigated amendments. Yet, it worthy to mention from the obtained results that the values of inorganic amendments (gypsum and sulphur) surpassed the farmyard manure one. In this respect, sulphur application attained the highest values compared with those attained with gypsum. Yet, there were significant differences between the effects of the three amendments and also between them and control. The contents of N, P and K in wheat grain, straw and whole plant and grain protein content gave also the same trends, where they were significantly increased with the application of soil amendments. The highest increments were also attained with sulphur followed by gypsum. The farmyard manure gave the least increases. The positive impacts of soil amendments on wheat crop production and its mineral compositions are mainly due to improving the soil physical, chemical and biological properties and preparing the suitable bed for germination and development of plant growth that reflect on the resultant yield. Moreover, the superiority effect of sulphur could be explained on the basis of the following topics :

1-The application of S furnished a proper environment for plant growth where it affects the high pH value by acid production directly as a result of bacterial activity and indirectly through sulphur oxidation. The shifting of the alkaline pH to the other side affects nutrients availability and increases their contents in plant organs (El-Shafie-Fatma and El-Gamaily-Eida, 2002 and Azer-Sohair *et al.*, 2003).

Table (2): Effect of soil amendments on the yield, yield components and some chemical compositions of wheat plants grown under saline alkali soils (Combined analysis of 2002/2003 and 2003/2004 growing seasons).

Amendments	Yield components				Yield/ fed.		Chemical compositions (kg/ fed.)									
							Nitrogen			Phosphorus			Potassium			
	Number of spikes/m^2	Number of spikelets /spike	Grain weight (g/ spike)	1000 grain eight (g)	Grain (ardab)	Straw (ton)	Grain	straw	Whole plant	Grain	straw	Whole plant	Grain	straw	Whole plant	Grain crude protein
Control	205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
Sulphur	210.8	18.57	2.58	50.13	14.31	5.51	47.9	15.6	63.5	3.91	3.76	7.67	10.1	33.9	44.0	273.0
Gypsum	211.1	15.20	2.40	45.40	13.21	4.76	41.9	12.1	54.0	3.29	2.70	5.99	8.1	25.0	33.1	238.8
Farmyard manure	206.9	14.15	2.29	43.50	12.30	4.45	38.8	10.7	49.5	2.68	2.23	4.91	6.4	22.0	28.4	221.2
L.S.D. at 0.05	N.S.	0.82	0.13	1.01	0.23	0.08	0.65	0.20	0.55	0.06	0.05	0.04	0.15	0.43	0.34	3.7

2- S element has important roles in plant protein and some hormones formation as well as it is necessary for enzymatic action, chlorophyll formation, synthesis of certain amino acids and vitamins. Hence, S helps to have a good vegetative growth leading to have a high yield and increasing the absorption of macro-and micronutrients (Marschner, 1998).

3- A shortage in the S supply for crop lowers the utilization and efficiency of N fertilization as well as increases the loss of N from the agricultural soils through volatilize-tion and leaching (Schnug *et al.*, 1993 and Fathi *et al.*, 2003).

These results are in hormony with El-Masry, 2001.

2-Effect of nitrogen fertilization:

Data obtained in Table (3) represented the mean values of the two levels of N-fertilization, i.e. the recommended level (75 kg N/fed.) and the half recommended one (37.5 kg N/fed.) compared with the control received 75 kg N/fed. and didn't receive any amendments or micron-utrients. These results indicated that the application of half recommended dose of N-fertilization caused sharply decreases in both grain and straw yields of wheat plants as well as the grain attributes. N, P and K contents in grain, straw and whole wheat plant and grain crude protein were also taken the same trend where they were significantly decreased with decreasing the rate of N-fertilization in comparison with the control treatment. On the contrary, all aforementioned characters were significantly increased as the addition of whole N-fertilization rate required for wheat plants compared with the plants received 37.5 kg N/fed. and the control treatment. The increase in wheat grain yield was mainly related to the enhancing effect of N-fertilization on the grain yield components (No. of spikes /m^2, No. of spikelets/spike, grain weight/spike and 1000 grain weight), as shown in Table (3). Data also revealed that nitrogen alone was more effective than the application of all soil amendments. Yet, the results also show that the plants adequately supplied with nitrogen achieved more yield attributes, grain and straw yields as well as better NPK and crude protein contents in comparison to those didn't adequately supply with nitrogen. These results are in agreement with Abd El-Rahman (1999); Sabry *et al.* (1999); Osman *et al.* (2000); El-Masry (2001) and Fathi *et al.* (2003). The role of N for increasing the wheat yield and its mineral composition has been well documented as it is required for the synthesis of proteins, protoplasm formation and its transferring to cell wall that manifested in enhancing the meristematic activities and increasing the cell size, leaf expansion and internode elongation. As a result, higher yields and better nutritive contents for wheat plants could be expected.

3- Effect of micronutrients application:

Data in Table (4) cleared that there were significant differences between the investigated micro-nutrients concerning grain and straw yields, grain attributes as well as NPK contents of both wheat grain and straw and grain crude protein. In this concern, Zn attained the highest increments for all the aforementioned characters followed by the addition of these micronutrients simultaneously. Moreover, foliar application of Cu gave the least increases. The beneficial effects of the studied micronutrients may be attributed to one or more of the following:

I-Lacking of the experimental soil sites for these nutrients (Table, 1) as a result of the extensive cropping systems and predo-minance of soil salinity and alkalinity.

II-These elements have promoting effects on the growth regulators and enzymes, enzymatic activities, photosynthetic processes as well as synthesis of protein, carbohydrates and libeids (Ibrahim and Shalaby, 1994; Nassar, 1997 and Marschner, 1998).

III-The addition of the tested micronutrients improve the transforming of photosynthetic substances from leaves to grains during the synthesis process. Yet, they produce better number of fertile tillers and spike because of inducing changes in the endogenous hormone ratios and predominance of cytokinins at the time of tillering (Szirtes *et al.*, 1986).

The greatest impact of Zn in increasing the abovementioned parameters may be due to that Zn is essential for the activity of various enzymes and delay the senescence of wheat plants through increasing the levels of indole acetic acid (IAA) and chlorophyll. Consequently, contents of nitrogen and some nutrients increase (Hemantaranjan and Garge, 1984). Yet, Zn is associated with carbohydrate metabolism and protein synthesis (Marschner, 1998).

The enhancing effect of micro-nutrients when their application together may be due the suitable balance between them required to obtain the best growth and the highest values of NPK contents (Nassar *et al.*, 2002). These findings are in good agreement with those obtained by Ibrahim and Shalaby, 1994; Nassar, 1997; El-Masry, 2001 and Nassar *et al.*, 2002.

Table (3): Effect of nitrogen fertilization rates on the yield, yield components and some chemical compositions of wheat plants grown on saline alkali soils (Combined analysis of 2002/2003 and 2003/2004 growing seasons).

N-fertilization rates (kg/fed.)	Yield components				Yield/fed.		Chemical compositions (kg/ fed.)									
							Nitrogen			Phosphorus			Potassium			
	Number of spikes / m^2	Number of spikelets /spike	Grain weight (g/ spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	straw	Whole plant	Grain	straw	Whole plant	Grain	straw	Whole plant	Grain crude protein
Control	205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
37.5	171.2	13.88	1.85	40.82	8.00	3.70	23.6	9.1	32.7	1.56	1.76	3.32	3.8	18.2	22.0	134.5
75.0	248.0	18.07	2.99	51.86	18.54	6.11	62.1	16.6	78.7	5.03	4.03	9.06	12.6	35.7	48.3	354.0
L.S.D. at 0.05	12.0	0.55	0.15	0.59	0.18	0.07	0.49	0.18	0.61	0.05	0.04	0.07	0.1	0.37	0.41	2.8

Table (4): Effect of micronutrients on yield and its components as well as some chemical compositions of wheat plants (combined analysis of 2002/2003 and 2003/2004 growing seasons).

Micronutrients	Yield components				Yield/fed.		Chemical compositions (kg/fed.)									Grain crude protein
							Nitrogen			Phosphorus			Potassium			
	Number of spikes/m^2	Number of spikelets/spike	Grain weight (g/spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	Straw	Whole plant	Grain	Straw	Whole plant	Grain	Straw	Whole plant	
Control	205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
Zn	215.2	18.13	2.54	47.09	14.14	5.26	46.2	14.1	60.3	3.81	13.59	7.40	9.1	29.5	38.6	263.3
Fe	206.3	14.90	2.37	45.96	12.84	4.77	41.1	12.2	53.3	3.05	2.58	5.63	7.7	25.9	33.6	234.3
Mn	208.7	15.90	3.42	46.34	13.30	4.82	42.9	12.7	55.6	3.30	2.90	6.20	8.2	26.7	34.9	244.5
Cu	210.0	13.95	2.32	45.67	12.70	4.69	40.4	11.8	52.2	2.87	2.25	5.12	7.5	25.2	32.7	230.3
Mixture	207.9	16.99	2.48	46.64	13.39	4.97	43.5	13.2	56.7	3.44	3.17	6.61	8.4	27.5	25.9	248.0
L.S.D. at 0.05	4.33	0.43	0.03	0.23	0.22	0.04	0.68	0.11	0.74	0.05	0.02	0.06	0.14	0.22	0.28	3.89

4- Interaction effect between soil amendments and nitrogen fertilization rates:

Data in Table (5-a) revealed that the soil fertilized with the half recommended dose of N (37.5 kg/fed.) under the application of all investigated soil amendments generally decreased both wheat grain and straw yields, their attributes and NPK contents. On the contrary, significant increments for all previous parameters were observed by the addition of the recommended rate of N (75 kg/fed.) along with all the soil amendments. The application of S and the recommended rate of N attained the highest increases compared with the other treatments. Sabry *et al.*, 1999; Osman *et al.*, 2000; El-Masry, 2001 and Fathi *et al.*, 2003 obtained results similar to the previous ones.

5-Interaction effect between soil amendments and foliar spraying of micronutrients:

Data recorded in Table (5-b) indicated that wheat straw yield and all studied yield attributes except number of spikelets/spike were significantly responded to foliar spraying with the tested micronutrients under the three amendments. N and K contents in straw and P content in grain and straw followed also the same above trends. In this concern, the highest increments for all examined parameters were observed by treating the soil with S and spraying the wheat plants with Zn. These results are in hormony with those obtained by El-Masry (2001).

6-Interaction effect between nitrogen fertilization rates and foliar spraying with micro-nutrients:

Data in Table (5-c) showed that all micronutrients treatments applied under soil fertilization with the half recommended dose of N (37.5 kg N/fed.) significantly decreased both wheat grain and straw yields and their NPK contents compared with the control treatment. On the other hand, opposite trends were obtained when spraying the wheat plants with each of micronutrients under investigation and fertilizing the soil with 75 kg N/fed. In this respect, Zn foliar application along with soil fertilization with 75 kg N/fed. scored the best values. However, Cu spraying at the same level of N-fertilization gave the least increments. Similar results were also observed by Osman *et al.*, 2000; Nassar *et al.*, 2002 and Fathi *et al.*, 2003.

Table (5): Yield component and grain & Straw yields as well as some chemical compositions of wheat plants grown on saline alkali soils as affected by:

(a) Soil amendments X nitrogen fertilization rates interactions:

Amendments	N-fertilization rates (kg/fed.)	Yield components				Yield/fed.		Chemical compositions (kg/fed.)									Grain crude protein
								Nitrogen			Phosphorus			Potassium			
		Number of spikes / m²	Number of spikelets/spike	Grain weight (g/spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	Straw	Whole plant	Grain	Straw	Whole plant	Grain	Straw	Whole plant	
Control		2050	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
Sulphur	37.5	171.3	16.13	2.06	44.93	8.99	4.08	28.3	10.7	39.0	1.85	2.40	4.25	4.7	23.0	27.7	161.3
	75.0	250.3	21.00	3.10	55.32	19.62	6.95	67.5	20.5	88.0	5.97	5.11	11.08	15.5	44.7	60.2	384.8
Gypsum	37.5	160.6	13.30	1.91	40.38	7.80	3.63	22.1	8.7	30.8	1.59	1.59	3.18	3.8	16.8	20.6	126.0
	75.0	261.6	17.10	2.89	50.41	18.62	5.89	61.6	15.6	77.2	4.99	3.81	8.80	12.4	33.2	45.6	351.1
Farmyard manure	37.5	181.6	12.20	1.59	37.15	7.21	3.40	20.4	7.8	28.2	1.24	1.30	2.54	3.0	14.8	17.8	116.3
	75.0	232.2	16.10	2.99	49.85	17.39	5.50	57.2	13.6	70.8	4.12	3.16	7.28	9.8	29.2	39.0	326.0
L.S.D. at 0.05		25.4	N.S.	N.S.	1.04	0.30	0.13	0.85	0.32	1.14	0.08	0.07	0.11	0.01	0.01	0.12	7.66

Table (5): Con.: (b) Soil amendments X micronutrients interactions:

Soil amendments	Micronutrients	Yield components				Yield/fed.		Chemical compositions (kg/fed.)									Grain crude protein
								Nitrogen			Phosphorus			Potassium			
		Number of spikes /m^2	Number of spikelets/spike	Grain weight (g/spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	Straw	Whole plant	Grain	Straw	Whole plant	Grain	Straw	Whole plant	
Control		205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
Sulphur	Zn	218.4	20.58	2.66	51.19	15.08	6.09	51.1	17.5	68.6	4.51	4.65	9.16	11.0	37.9	48.9	291.3
	Fe	207.1	17.73	2.54	49.49	13.90	5.31	46.1	14.9	61.0	3.64	3.34	7.00	9.7	32.3	42.0	262.8
	Mn	206.8	18.40	2.58	50.19	14.31	5.37	48.0	15.2	63.2	3.93	3.69	7.62	10.1	33.1	43.2	273.6
	Cu	208.7	16.73	2.51	49.27	13.76	5.25	45.3	14.5	59.8	3.40	2.83	6.23	9.4	31.7	41.1	258.2
	Mixture	213.0	19.41	2.62	50.50	14.50	5.56	48.9	15.9	64.8	4.08	4.28	8.36	10.4	34.4	44.8	278.7
Gypsum	Zn	211.9	17.75	2.56	46.11	14.00	5.02	45.1	13.3	58.4	3.76	3.38	7.14	8.9	27.0	35.9	257.1
	Fe	206.2	13.92	2.33	45.26	12.68	4.65	39.9	11.6	51.5	3.05	2.32	5.37	7.6	24.2	31.8	227.4
	Mn	211.7	15.25	2.38	45.50	13.22	4.73	41.8	12.1	53.9	3.29	2.71	6.00	8.1	24.9	33.0	238.3
	Cu	218.6	12.59	2.28	44.45	12.86	4.58	40.0	11.2	51.2	2.92	2.06	4.98	7.5	23.6	31.1	228.0
	Mixture	207.2	16.50	2.46	45.66	13.30	4.83	42.5	12.7	55.2	3.46	3.04	6.50	8.4	25.5	33.9	242.3
Formyard manure	Zn	215.2	16.06	2.41	43.98	13.36	4.68	42.6	11.5	54.1	3.18	2.74	5.92	7.3	23.6	30.9	242.8
	Fe	205.4	13.05	2.24	43.14	11.95	4.35	37.5	10.3	47.8	2.47	2.07	4.54	6.0	21.2	27.2	213.8
	Mn	207.6	14.05	2.29	43.34	12.37	4.45	38.9	10.8	49.7	2.69	2.29	4.98	6.4	22.1	28.5	221.7
	Cu	202.6	12.55	2.17	43.30	11.48	4.25	35.9	9.9	45.8	2.28	1.87	4.15	5.7	20.5	26.2	204.6
	Mixture	203.6	15.06	2.35	43.75	12.37	4.53	39.2	11.2	50.4	2.78	2.20	4.98	6.6	22.7	29.3	223.4
L.S.D. at 0.05		7.50	N.S.	0.05	0.40	N.S.	0.07	N.S.	0.18	N.S.	0.08	0.04	0.11	N.S.	0.38	0.49	N.S.

Table (5): Con.: (c) Nitrogen fertilization rates X micronutrients interactions:

N-fertilization rates (kg/fed.)	Micronutrients	Yield components				Yield/fed.		Chemical compositions (kg/fed.)									Grain crude protein
								Nitrogen			Phosphorus			Potassium			
		Number of spikes/m^2	Number of spikelets/spike	Grain weight (g/spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	Straw	Whole plant	Grain	Straw	Whole plant	Grain	Straw	Whole plant	
Control		205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
37.5	Zn	178.7	15.92	1.96	41.72	8.77	4.10	26.5	10.3	36.8	1.89	2.29	4.18	4.4	20.7	25.1	151.1
	Fe	165.4	12.85	1.80	40.34	7.48	3.55	21.7	8.5	30.2	1.37	1.53	2.90	3.4	17.2	20.6	123.7
	Mn	170.3	13.80	1.84	40.81	8.08	3.63	23.8	8.9	32.7	1.58	1.71	3.29	3.8	17.8	21.6	135.7
	Cu	171.1	12.01	1.76	40.07	7.58	3.48	21.7	8.2	29.9	1.30	1.29	2.59	3.4	16.8	20.2	123.7
	Mixture	170.3	14.81	1.90	41.17	8.09	3.76	24.2	9.3	33.5	1.66	1.99	3.65	4.0	18.6	22.6	137.9
75.0	Zn	251.6	20.33	3.12	52.47	19.51	6.42	66.0	17.9	83.9	5.73	4.88	10.61	13.7	38.3	52.0	376.2
	Fe	247.2	16.94	2.93	51.77	18.19	5.99	60.6	15.9	76.5	4.73	3.62	8.35	12.0	34.5	46.5	345.4
	Mn	247.1	18.00	2.99	51.87	18.52	6.07	61.9	16.4	78.3	5.03	4.08	9.11	12.6	35.5	48.1	352.8
	Cu	248.8	15.89	2.87	51.27	17.81	5.90	59.0	15.4	74.4	4.43	3.21	7.64	11.6	33.7	45.3	336.3
	Mixture	245.5	19.17	3.05	52.10	18.69	6.18	62.9	17.2	80.1	5.21	4.35	9.56	12.9	36.5	49.4	358.5
L.S.D. at 0.05		N.S.	N.S.	N.S.	N.S.	N.S.	0.06	0.97	1.15	1.05	0.06	0.03	0.09	0.20	0.31	0.4	5.51

7- Interaction effect between soil amendments, nitrogen fertilization rates and foliar spraying of micronutrients:

Data presented in Table (6) clearly showed that, in most cases, fertilizing the soil with the half recommended dose of N, i.e. 37.5 kg N/fed. under the addition of all tested soil amendments and spraying the wheat plants with the treatments of micronutrients significantly decreased all parameters related to wheat grain and straw yields and their chemical compositions. On the contrary, highly significant increments for all aforementioned parameters were scored when the application soil amendments and micronutrients spraying along with soil fertilization with 75 kg N/fed. The maximum responses of wheat plants to the three factors under investigation were possessed when the application of S as a soil amendment and soil fertilization with 75 kg N/fed. along with Zn foliar spraying. However, using farmyard manure as a soil amendment at 37.5 kg N/fed. and spraying the plants with Cu attained the least values compared with the control. The same trends were also obtained by Khader-Saffaa, 1998; Fathi *et al.*, 2003; Kandel, 2003 and Salem, 2003.

Data shown in Table (6) also assured the following four important points:

First: Sulphur is the most effective amendment compared with the other ones, under the condition of this experiment.

Second: It is necessary to supply the wheat plants with the recommended rate of N-fertilization, i.e. 75kg N/fed. as sake of producing the highest grain and straw yields, improving their nutritive contents and obtaining the highest content of grain protein.

Third: Spraying the wheat plants with Zn achieve the highest values of grain and straw yields and their NPK contents.

Fourth: Application of S as a soil amendment, soil fertilizing with 75 kg N/fed. and spraying the wheat plants with Zn, simultaneously gave an additional promoting effect on both quantity and quality of wheat crop.

8-Effect of the investigated soil amendments on some soil chemical characteristics:

Data in Table (7) represented the chemical analyses of the soils, under investigation, at the beginning and end of the experiments. It worthy to notice that under leaching process, the initial (EC) values of the soils at the two seasons dropped at the end of the experiments as the application of the investigated soil amendments. In this respect, gypsum application was the most effective in decreasing soil salinity followed by sulphur and farmyard manure in a descending order. This is mainly related to the effect of gypsum on neutralizing the alkali reaction which results in increasing the soil permeability. Thus, salt removal by subsequent leaching increase. On the contrary, it is expected that the soil leached

Table (6): Interaction effect between soil amendments, N-fertilization rates and micronutrients on yield components and grain & straw yields as well as some chemical compositions of wheat plants grown on saline alkali soils (combined analysis of 2002/2003 and 2003/2004 seasons).

Soil amendments	N-fertilization rates (kg/fed.)	Micronutrients	Yield components: Number of spikes/ m^2	Yield components: Number of spikelets/spike	Yield components: Grain weight (g/spike)	Yield components: 1000 grain weight (g)	Yield/fed.: Grain (ardab)	Yield/fed.: Straw (ton)	Chemical compositions (kg/fed.): Nitrogen: Grain	Nitrogen: Straw	Nitrogen: Whole plant	Phosphorus: Grain	Phosphorus: Straw	Phosphorus: Whole plant	Potassium: Grain	Potassium: Straw	Potassium: Whole plant	Grain crude protein
Control			20.50	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	2.0	25.9	199.5
Sulphur	37.5	Zn	180.4	18.15	2.14	46.05	9.64	4.84	31.2	13.0	44.2	2.24	3.15	5.39	5.2	27.8	33.0	177.8
		Fe	167.3	15.45	2.02	44.15	8.50	3.86	26.1	9.9	36.0	1.63	2.12	3.75	4.3	21.6	25.9	148.8
		Mn	165.8	15.80	2.05	45.23	9.02	3.87	28.6	10.2	38.8	1.83	2.23	4.06	4.7	21.9	26.6	163.0
		Cu	170.6	14.45	1.99	43.78	8.61	3.78	26.1	9.6	35.7	1.55	1.80	3.35	4.3	21.0	25.3	148.8
		Mixture	172.4	16.81	2.10	45.45	9.18	4.04	29.3	10.7	40.0	2.00	2.72	4.72	4.8	22.8	27.6	167.0
	75.0	Zn	256.4	23.00	3.18	56.32	20.51	7.33	71.0	22.0	93.0	6.77	6.14	12.91	16.7	48.0	64.7	404.7
		Fe	247.0	20.00	3.05	54.83	19.29	6.76	66.0	19.9	85.9	5.64	4.56	10.20	15.0	42.9	57.9	376.2
		Mn	247.7	21.00	3.11	55.14	19.60	6.86	67.4	20.2	87.6	6.03	5.15	11.18	15.5	44.3	59.8	384.2
		Cu	246.9	19.00	3.03	54.75	18.90	6.72	64.4	19.3	83.7	5.24	3.86	9.10	14.5	42.3	56.8	367.1
		Mixture	253.6	22.00	3.13	55.55	19.82	7.07	68.5	21.0	89.5	6.16	5.83	11.99	15.9	46.0	61.9	390.5
Gypsum	37.5	Zn	163.7	15.50	2.05	41.30	8.55	3.79	24.9	9.3	34.2	1.90	2.08	3.98	4.4	18.0	22.4	141.9
		Fe	151.9	12.00	1.84	40.28	7.15	3.54	20.0	8.3	28.3	1.38	1.33	2.71	3.3	16.2	19.5	114.0
		Mn	163.4	13.50	1.89	40.45	7.91	3.62	22.4	8.7	31.1	1.65	1.63	3.28	3.8	16.8	20.6	127.7
		Cu	167.5	11.00	1.81	39.30	7.78	3.48	21.4	8.0	29.4	1.40	1.13	2.53	3.6	15.8	19.4	122.0
		Mixture	156.5	14.50	1.96	40.56	7.62	3.71	21.8	9.0	30.8	1.64	1.76	3.40	3.8	17.3	21.1	124.3
	75.0	Zn	260.1	20.00	3.07	50.92	19.44	6.24	65.2	17.2	82.4	5.61	4.68	10.29	13.4	35.9	49.3	371.6
		Fe	260.6	15.83	2.81	50.24	18.20	5.76	59.8	14.8	74.6	4.71	3.31	8.02	11.8	32.1	43.9	340.9
		Mn	260.0	17.00	2.87	50.54	18.52	5.83	61.2	15.4	76.6	4.93	3.79	8.72	12.4	32.9	45.3	348.8
		Cu	269.6	14.17	2.74	49.60	17.94	5.67	58.6	14.3	72.9	4.44	2.98	7.42	11.4	31.3	42.7	334.0
		Mixture	257.8	18.50	2.96	50.75	18.98	5.94	63.1	16.3	79.4	5.27	4.31	9.58	12.9	33.7	46.6	359.7
Farmyard manure	37.5	Zn	192.0	14.12	1.69	37.80	8.13	3.66	23.4	8.5	31.9	1.53	1.65	3.18	3.6	16.3	19.9	133.4
		Fe	176.9	11.10	1.54	36.60	6.80	3.26	19.0	7.4	26.4	1.10	1.14	2.24	2.7	13.9	16.6	108.3
		Mn	181.7	12.10	1.59	36.74	7.30	3.39	20.5	7.8	28.3	1.26	1.27	2.53	3.0	14.7	17.7	116.9
		Cu	175.3	10.59	1.49	37.12	6.36	3.17	17.7	7.1	24.8	0.95	0.95	1.90	2.4	13.5	15.9	100.9
		Mixture	182.1	13.11	1.64	37.49	7.47	3.52	21.4	8.2	29.6	1.35	1.50	2.85	3.3	15.6	18.9	122.0
	75.0	Zn	238.4	18.00	3.12	50.16	18.58	5.69	61.7	14.5	76.2	4.82	3.83	8.65	11.0	30.9	41.9	351.7
		Fe	234.0	15.00	2.93	49.68	17.09	5.44	55.9	13.1	69.0	3.84	2.99	6.83	9.3	28.4	37.7	318.6
		Mn	233.6	16.00	2.99	49.93	17.43	5.51	57.2	13.7	70.9	4.12	3.30	7.42	9.8	29.4	39.2	326.0
		Cu	229.8	14.50	2.85	49.47	16.60	5.32	54.1	12.6	66.7	3.61	2.78	6.39	8.9	27.5	36.4	308.4
		Mixture	225.1	17.00	3.06	50.01	17.26	5.54	57.0	14.2	71.2	4.21	2.90	7.11	9.9	29.8	39.7	324.9
L.S.D. at 0.05:			N.S.	N.S.	N.S.	N.S.	N.S.	0.10	N.S.	0.26	N.S.	0.11	0.06	0.16	N.S.	0.54	0.69	N.S.

Table (7): Interaction effect between soil amendments and nitrogen fertilization rates on the yield, yield components and some chemical compositions of wheat plants grown on saline alkali soils (Combined analysis of 2002/2003 and 2003/2004 growing seasons).

Amendments	N-fertilization rates (kg/ fed.)	Yield components				Yield/ fed.		Chemical compositions (kg/ fed.)									Grain crude protein
								Nitrogen			Phosphorus			Potassium			
		Number of spikes/ m^2	Number of spikelets /spike	Grain weight (g/ spike)	1000 grain weight (g)	Grain (ardab)	Straw (ton)	Grain	straw	Whole plant	Grain	Straw	Whole plant	Grain	straw	Whole plant	
Control		205.0	14.00	2.10	41.54	11.25	4.30	35.0	9.8	44.8	2.38	2.00	4.38	5.9	20.0	25.9	199.5
Sulphur	37.5	171.3	16.13	2.06	44.93	8.99	4.08	28.3	10.7	39.0	1.85	2.40	4.25	4.7	23.0	27.7	161.3
	75.0	250.3	21.00	3.10	55.32	19.62	6.95	67.2	20.5	88.0	5.97	5.11	11.08	15.5	44.7	60.2	384.8
Gypsum	37.5	160.6	13.30	1.91	40.38	7.80	3.63	22.1	8.7	30.8	1.59	1.59	3.18	3.8	16.8	20.6	126.0
	75.0	261.6	17.10	2.89	50.41	18.62	5.89	61.6	15.6	77.2	4.99	3.81	8.80	12.4	33.2	45.6	351.1
Farmyard manure	37.5	181.6	12.20	1.59	37.15	7.21	3.40	20.4	7.8	28.2	1.24	1.30	2.54	3.0	14.8	17.8	116.3
	75.0	232.2	16.10	2.99	49.85	17.39	5.50	57.2	13.6	70.8	4.12	3.16	7.28	9.8	29.2	39.0	326.0
L.S.D. at 0.05		20.7	N.S.	0.26	N.S.	0.32	0.13	0.85	0.32	1.06	0.09	6.11	0.11	0.17	0.65	0.70	4.9

without the addition of the amendments (control treatment) may be converted to an alkali soil.

Data shown in Table (7) also revealed that the application of sulphur, gypsum or farmyard manure had acidic effects and hence reducing the soil pH values. These depressing impacts could be attributed to the following reasons:

1- The soil application of gypsum produce SO_4^{2-} ions which converted to H_2SO_4 that interact with Ca^{2+} ions and decrease both soluble and exchangeable Na^+ in the soil (Abou El-Defan *et al.*, 1999 and El-Masry, 2001) .

2- Sulphur application to the soil led to its oxidation to SO_4^{2-} and sulphuric acid by specific soil microbes and hence reducing soil alkalinity (El-Masry, 2001; Fathi *et al.* 2003 and Salem, 2003).

3- Decreasing of soil pH caused by the application of organic manure may be related to its decomposition and formation of organic complexes and acids (El-Shafie-Fatma and El-Gamaily-Eida, 2002; Salem, 2003 and Kandel, 2003).

The effect of the investigated soil amendments on soluble ions of saline sodic soil at the two seasons are also presented in Table (5). It is obvious that gypsum markedly increased the concentration of Ca^{2+} and SO_4^{2+} ions while it sharply decreased Na^+ concentration. Similar results were also obtained by (Khader-Saffaa, 1998 and El-Masry, 2001). The beneficial effects of the tested soil amendments on physical characteristics may be increased the movement of ions in the drainage water. Na^+ ions were the dominant cations to be removed from the soil. On the other hand, the application of soil amendments had no appreciable effect on the soluble Mg^{2+} and K^+ ions, where the differences between treatments were almost negligible.

Data in Table (7) also revealed that the exchangeable cations of the soil related to the studied amendments induced trends similar to those of soluble ones, where considerable increase in exchangeable Ca^{2+} and pronounced decreases in exchangeable Na^+ and ESP were observed as the application of soil amendments, meanwhile gypsum was the most effective amendment compared with the other amendments.

Hence, it can be recommended the reclaimation of saline sodic soils and improving their properties as well as obtaining the best quantity and quality of wheat crop through the addition of 1 ton S, soil fertilization with 75 kg N/fed. and spraying the wheat plants with 0.3 g Zn/L (400 L/fed.).

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تحسين إنتاجية وصفات محصول القمح فى الأراضى المتأثرة بالأملاح

كرم السيد محمد نصار ، مطاوع مطاوع الشونى ،
السيد محمد قطب بحيرى
معهد بحوث الأراضي والمياه والبيئة ـ مركز البحوث الزراعية ـ
الجيزة ـ مصر

يعانى محصول القمح فى الأراضي المتأثرة بالأملاح من العديد من المشاكل المرتبطة بملوحة وقلوية التربة والتي تنعكس بدروها على تيسر العناصر الغذائية فى التربة وامتصاص النبات لها ٠٠ لذا اتجه هذا البحث إلى النهوض بإنتاجية محصول القمح النامي فى مثل هذه الأراضي وتحسين صفاته من خلال تحسين خواص التربة الطبيعية والكيميائية والحيوية بإضافة بعض المصلحات إليها ٠٠ فضلا عن أن تقنين التسميد الآزوتي وتقليل كميته بإضافة المصلحات والرش بالعناصر الصغرى كان هدفا من أهداف هذه الدراسة ٠٠ ولتحقيق هذه الأهداف أقيمت تجربتان حقليتان فى محطة البحوث الزراعية بسدس ـ محافظة بنى سويف ـ خلال موسمى النمو الشتويين ٢٠٠٢/٢٠٠٣، ٢٠٠٣/٢٠٠٤ أستخدم فيهما ثلاثة مصلحات للتربة هى المادة العضوية ، الكبريت ، الجبس بمعدلات ٢٠متر مكعب ، ١ طن ، ٥ طن/فدان على الترتيب ، كما أضيف السماد الآزوتي بمستويين : الموصى به ونصف الموصى به (٧٥ ، ٣٧,٥ كجم نيتروجين /فدان) والرش بعناصر الزنك ، المنجنيز ، الحديد ، النحاس ، مخلوط منهم فى صورها المخلبية وذلك بتركيز ٠,٣ جم/لتر لكل من الزنك ، المنجنيز ، الحديد ، ٠,١٥ جم/لتر بالنسبة لعنصر النحاس .

حللت النتائج المتحصل عليها إحصائيا باستخدام التحليل المشترك لكلا موسمي النمو ، وقد أشارت هذه النتائج (كمتوسطات لقيم موسمي الزراعة) إلى النقاط الهامة الآتية:

١- استجاب محصولي الحبوب والقش لنباتات القمح وكذلك المحتوى الغذائي لكل منهما ومحتوى الحبوب من البروتين معنويا لإضافة المصلحات المختبرة للتربة ٠٠ وفى هذا الصدد سجلت إضافة المصلحات الكيميائية (الجبس ، الكبريت) قيما أعلى من تلك المسجلة عند إضافة المادة العضوية للتربة كما سجلت إضافة الكبريت أعلى القيم مقارنة بباقي المصلحات الأخرى .

٢- لا يمكن خفض معدل التسميد النيتروجيني إلى نصف المعدل الموصى به بغرض الحصول على أفضل محصول اقتصادى من الحبوب والقش ورفع قيمتهما الغذائية .

٣- حققت معاملة الرش بعنصر الزنك أفضل الزيادات بالنسبة لجميع الصفات المدروسة مقارنة بباقى معاملات العناصر الصغرى.

٤- إضافة المصلحات بالأراضي المتأثرة بالأملاح يرفع من كفاءة استخدام الأزوت بها وأيضا يعظم من الاستفادة من العناصر الصغرى المضافة بالرش وقد انعكس ذلك على جميع المقاييس المحصولية لنباتات القمح ومحصولي الحبوب والقش ومحتوياتهما من العناصر الغذائية وكذلك محتوى الحبوب من البروتين مقارنة بمعاملة الكنترول المسمدة بالنيتروجين والغير مستصلحة أو المضاف إليها العناصر الصغرى ٠٠ وكانت أكثر المعاملات تفوقا هى إضافة (١ طن كبريت + ٧٥ كجم نيتروجين +٤٠٠ لتر من الزنك تركيز ٠,٣ جم زنك/لتر فى صورته المخلبية)/فدان بينما حققت معاملة التسميد العضوي عند نفس المستوى من التسميد النيتروجيني والرش بعنصر النحاس أقل الزيادات .

٥- إضافة المصلحات للتربة أدى إلى خفض رقم pH وكان تأثير المصلحات كالآتي :

الكبريت > الجبس > المادة العضوية كما أدت إضافة هذه المصلحات إلى انخفاض واضح فى النسبة المئوية للصوديوم الذائب والمتبادل قابلتها زيادة واضحة فى النسبة المئوية للكالسيوم الذائب والمتبادل وهنا تفوقت إضافة الجبس على إضافة باقي المصلحات للتربة.

ومن ثم يمكن القول أنه ــ تحت ظروف مثل هذه التجربة ــ يمكن تحسين الخواص الطبيعية والكيميائية للأراضي المتأثرة بالأملاح ورفع كفاءة التسميد النيتروجيني بها وتعظيم الاستفادة من رش العناصر الغذائية الصغرى بإضافة محسنات التربة الكيميائية إليها وبخاصة الكبريت بمعدل ١ طن/فدان مع التسميد النيتروجيني بمعدل ٧٥ كجم نيتروجين/ فدان والرش الورقى بالزنك المخلبى بمعدل ٠,٣ جم زنك/لتر (٤٠٠ لتر/فدان) بغرض الحصول على أفضل محصول كمي للقمح مع تحسين صفاته الغذائية وزيادة نسبة البروتين بالحبوب .