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IMPACT OF BICARBONATE CONTENT OF IRRIGATION WATER, FARMYARD MANURE AND SULPHUR ON WHEAT PRODUCTION AND AVAILABLE MICRONUTRIENTS

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ABSTRACT

This study was carried out on a calcareous sandy loam soil at Sudr Research Station, South Sinai for conserving soil from the bicarbonate hazard in saline irrigation water. Four bicarbonate levels; 2.5, 5, 10 and 15 meqL^{-1} in saline irrigation water were applied. Also, three farmyard manure rates (0, 10, 20 m^3 fed^{-1}) and sulphure rates (0, 250 and 500 kg fed^{-1}) were applied individual and/or in combined. The organic manure and sulphure had positively significant effects on yield. The results also show that the highest value of grain and straw yields were obtained from $(HCO_3)_1OM_2S_2$ but the best treatment from economic point of view was $(HCO_3)_2OM_1S_2$. The highest values of available Fe^{++}, Mn^{++} and Zn^{++} were found with OM_2S_2 under all bicarbonate concentrations in saline irrigation water.

Keywords: Calcareous sandy loam soil, saline irrigation water, FYM, sulphur, wheat production and available micronutrients.

INTRODUCTION

In Egypt, calcareous soils represent about 25% of the new reclaimed area. Because of the limiting water supply, the need of expanding agricultural lands had to use saline water in irrigation which caused soil deterioration in some areas.

Mengel *et al.*, (1984) interpreted the reduction in the yield of plant due to HCO^-_3 to one or to more of the following reasons (a) the adverse effect of HCO_3 on the plant metabolic processes, (b) the disturbance of the plant nutrient balance, (c) the excess of HCO_3 induced the dominance of $CO_3^{=}$, ions which react with free soluble Zn in soil solution.

El-Shall *et al.*, (1987) found that sulphur was referred to its influence on reducing soil pH, improving soil structure and increasing the availability of certain nutrients.

Aich *et al.*, (1997) stated that grain yield of wheat was decreased with increasing salinity of irrigation water in all three soils. Application of decomposed cow dung decomposed straw, gypsum or lime increased grain yield.

Clarck *et al.*, (1999) mentioned that sorghum aerial plant and root production decreased with increasing salinity. Plant Ca, Sr, Mn and Cd levels increased with increasing salinity. In contrast, sorghum K, P, and S levels declined with increasing salinity.

The aim of the present work is to understand the interactions between bicarbonate, farmyard manure and sulphur.

MATERIALS AND METHODS

A field experiment was carried out at Sudr Research Station, South Sinai, in split-split design. The field was divided into plots (1/400 fed), 3 X 3.5 m. All treatments received constant rates, from NPK (80, 30 and 48 kg fed^{-1}) as N, P_2O_5 and K_2O, respectively as form ammonium nitrate, super phosphate and potassium sulphate respectively. Farm yard manure and sulphur were applied at rates of (0, 10 and 20 m^3 fed^{-1}) from FYM and 0, 250 and 500 kg S fed^{-1}. The wheat seeds (Sakha 8) were cultivated through two seasons 1999/2000 and 2000/2001. Grain and straw yields were evaluated at harvesting. After harvesting of wheat plants, representative soil samples were taken from 0-15, 15 -30 and 30 - 45 cm depths of each replicate to determine the soil chemical and physical properties under investigation. O.M%, Soil pH, EC, soluble cations and anions also ESP were determined according to Jackson (1967) and Chapman and Pratt (1961).

Table 1: Some physical properties of the experimental soils at Ras Sudr.

Soil depth (cm)	Particle size distribution (%)				Texture class	Bulk Density (g cm^{-3})	Field capacity (%)	Wilting point (%)	Av. water (%)	$CaCO_3$ (%)
	Coarse Sand	Fine Sand	Silt	Clay						
0-15	39.45	39.69	8.46	12.40	Sandy loam	1.44	18.90	9.52	50.90	50.90
15-30	37.20	43.31	12.22	7.27	Sandy loam	1.53	17.80	10.48	61.56	61.56
30-45	37.40	42.22	13.10	7.28	Sandy loam	1.52	17.30	10.63	51.32	51.32

Table 2: Some chemical properties of the experimental soils at Ras Sudr.

Soil depth (cm)	pH	EC (dSm^{-1})	Soluble cations (meqL^{-1})			Soluble anions (meq L^{-1})				ESP
			Ca^{+2} + Mg^{+2}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
0-15	7.4	14.3	97.71	79.80	0.01	--	3.54	133.47	50.90	13.60
15-30	7.4	13.60	84.00	82.54	0.01	--	6.80	1.70	61.56	14.92
30-45	7.4	11.70	84.88	58.75	1.80	--	5.16	74.97	51.32	10.75

Well water analyses were determined as previously mentioned in soil extracts and are given in Table 3.

Table 3: Analyses of the saline well water used for irrigation.

EC (dS m^{-1})	Soluble cations (meq L^{-1})			Soluble anions (meq L^{-1})				SAR
	Ca^{++} + Mg^{++}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	
10.20	62.80	80.13	1.18	--	2.50	81.90	39.60	10.70

FYM analyses were determined according to Jackson (1967), Lindsay and Norvell (1978) and Frie *et al.*, (1964). The obtained data are showed in Table 4.

Table 4: Analyses of the applied farmyard manure.

EC (dSm^{-1})	pH	O. C. (%)	Water holding capacity (%)	Total N (%)	C/N (ratio)	Total P (%)	Total K (%)	Total sulphate (%)	Total micronutrients (mg kg^{-1})		
									Fe	Mn	Zn
34.9	7.3	20.3	180	1.52	13.4	0.92	1.48	1.24	212	127	98

Finally, the statistical analysis of the obtained data was done according to the method described by Gomez and Gomez (1984) using LSD to compare the mean values of treatments.

RESULTS AND DISCUSSION

Data in Tables 5 and 6 reveal that grain and straw yields of wheat (ton fed^{-1}) were affected by the interaction between bicarbonate, organic manure and sulphur application during the two seasons. Table 5 shows that the effect of organic manure and sulphur was the best in case of OM_2 S_2 through the concentration of 5 $meqL^{-1}$ bicarbonate, while the same effect was in case of 10 $meqL^{-1}$ HCO_3^- less than 5 $meqL^{-1}$ where, the bicarbonate increased the deterious effect, while the more pronounced effects of FYM and S applications were noticed in the 1st season.

Table 5: Grain yields of wheat (ton fed^{-1}) as affected by bicarbonate, organic manure and sulphur application during the two studied seasons.

Treatments	1st season											
	Control			HCO_3^- (5meq L^{-1})			HCO_3^- (10meq L^{-1})			HCO_3^- (15meq L^{-1})		
	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2
S_0	1.17	2.10	2.22	1.16	2.05	2.21	0.92	1.46	1.50	0.50	0.74	0.86
S_1	1.51	2.20	2.36	1.49	2.17	2.35	0.98	1.47	1.62	0.55	0.88	0.93
S_2	1.94	2.25	2.45	1.91	2.24	2.44	1.10	1.51	1.70	0.68	0.91	0.97
LSD at 0.05	0.28											
	2nd season											
S_0	0.80	0.84	0.85	0.51	0.62	0.71	0.50	0.52	0.71	0.38	0.39	0.41
S_1	0.86	0.93	0.94	0.56	0.69	0.82	0.56	0.68	0.81	0.53	0.64	0.71
S_2	0.94	1.04	1.26	0.64	0.75	1.11	0.63	0.72	0.86	0.60	0.70	0.77
LSD at 0.05	0.21											

Table 6: Straw yields of wheat (ton fed^{-1}) as affected by bicarbonate, organic manure and sulphur application during the two studied seasons.

Treatments	1st season											
	Control			HCO_3^- (5meq L^{-1})			HCO_3^- (10meq L^{-1})			HCO_3^- (15meq L^{-1})		
	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2	OM_0	OM_1	OM_2
S_0	2.65	2.96	3.46	2.61	2.69	2.80	1.83	2.12	2.25	1.65	1.70	1.97
S1	3.63	4.27	4.62	2.74	3.46	4.15	2.12	2.24	2.28	1.68	2.06	2.10
S2	4.15	4.59	5.28	3.30	4.07	4.18	2.15	2.32	2.90	1.75	2.25	2.56
LSD at 0.05	0.78											
	2nd season											
S_0	1.76	1.90	2.79	1.52	1.78	1.91	1.35	1.51	1.61	1.10	1.15	1.57
S_1	1.94	2.34	2.88	1.90	2.06	2.62	1.88	2.06	2.39	1.26	1.67	2.03
S_2	2.40	2.71	2.98	2.27	2.59	2.78	2.18	2.54	2.64	1.56	2.24	2.34
LSD at 0.05	0.69											

The second season data (2000-2001) show that there is sharply decreasing trend was noticed in grains yield. This may be due to bicarbonate salt accumulation. The treatment of $(HCO_3)_1$ OM_2S_2 was the best treatment, but from economic point of view the best treatment was $(HCO_3)_2OM_1S_2$. The bicarbonate concentration at 10 and 15 meqL^{-1} had harmful negatively effect on the yield for both grains and straw.

The reduction in the yield of plant may be due to the following reasons, a) Adverse effect of HCO_3^- on plant metabolic processes; b) Disturbance of nutrients balance; and C) Excess of (HCO_3^-) induce of CO_3^{--} ions, which react with free soluble Zn^{++} in soil solution and induce chlorosis. Similar results were obtained by Mengle *et al.* (1984).

Sulphur was referred to its influence on reducing soil pH, improving soil structure and increasing the availability of certain plant nutrients (El-Shall *et al.*, 1987 and Aziz, 1998).

With respect to available micronutrients in soil, Figs 1 to 3 show that the highest values of available Fe, Mn and Zn were obtained in case of OM_2S_2 at all treatments of HCO_3^- in saline irrigation water. This may be due to the nutrients content of FYM and the different acids, which were produced from decomposition of FYM and may decrease soil pH. Sulphur application also may have a role in decrease soil pH and increasing micronutrients availability.

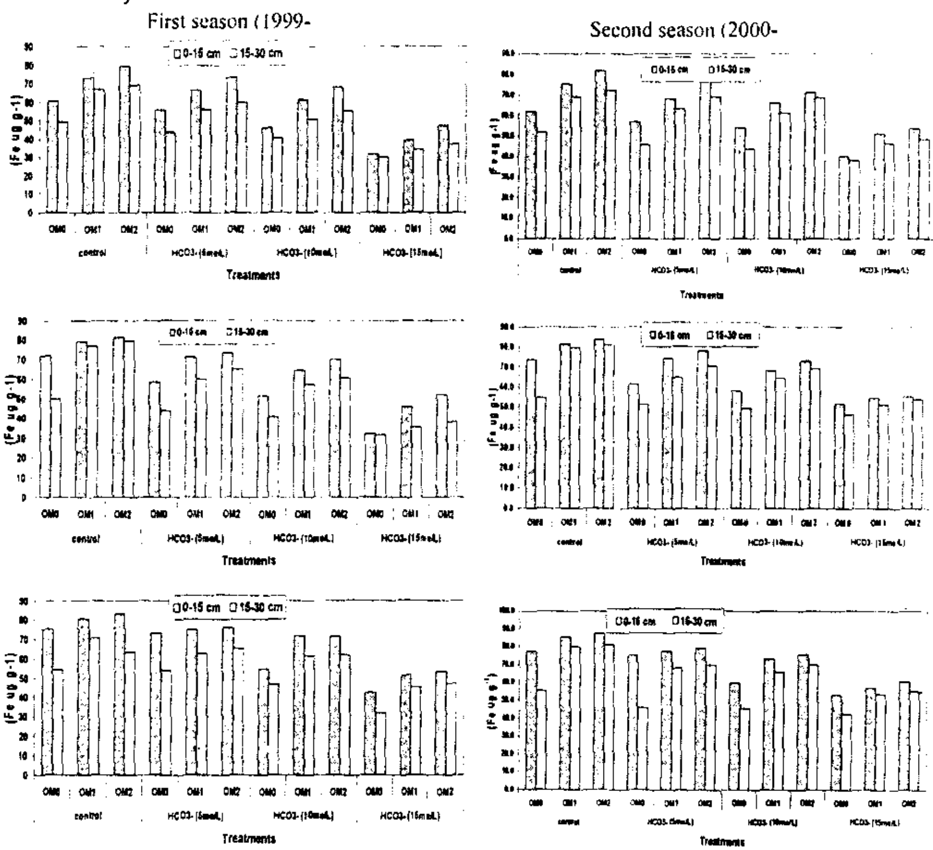

Fig. 1: Available Fe in (mg kg soil^{-1}) as affected by bicarbonate, organic manure and sulphur application.

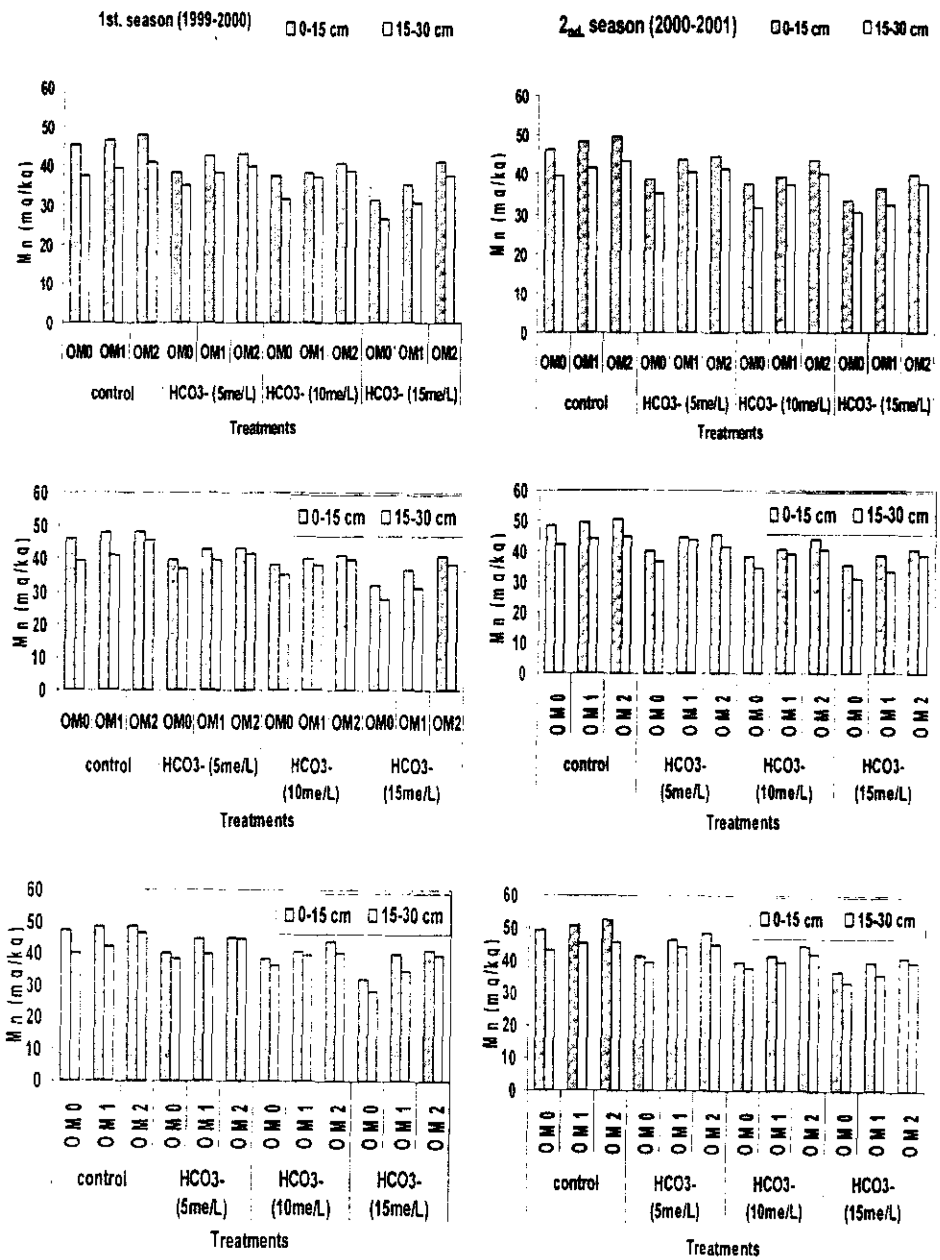

Fig 2: Available Mn in (mg kg soil^{-1}) as affected by bicarbonate, organic manure and sulphur application.

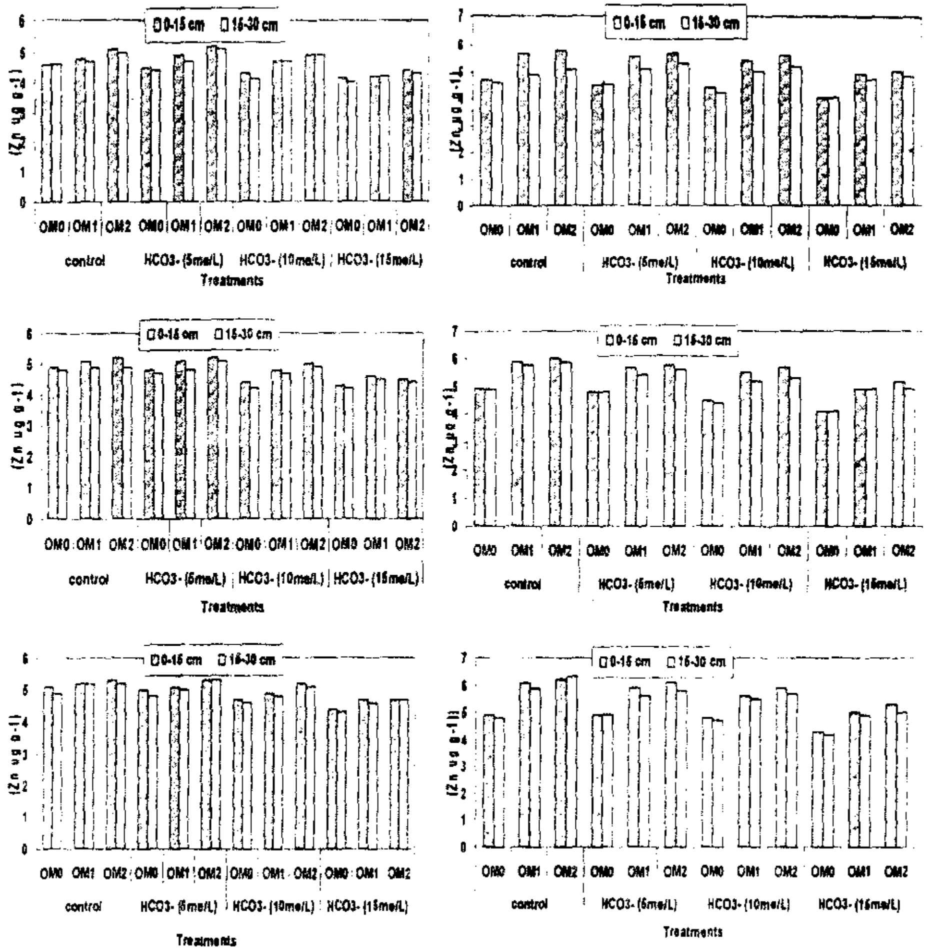

Fig. 3: Available Zn in (mg kg soil^{-1}) as affected by bicarbonate, organic manure and sulphur application.

Conclusion

Grains and straw yield of wheat was the highest value in case of $(HCO_3)_1$ OM_2S_2 in the first and second seasons. The harmful negatively effect of HCO_3 ions was clear through the second season. This due to HCO_3 salt accumulation at 10 and 15 meqL^{-1}.

From the economic point of view the best treatment was $(HCC_3)_2$ OM_1S_2. Available micronutrients in soil raised with increasing FYM and S rates.

The highest values of available Fe, Mn and Zn were in case of OM2S2 at all treatments of HCO^-_3.

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تأثير محتوي مياه الري من البيكربونات وسماد المزرعة والكبريت على انتاجية القمح وتيس العناصر الصغرى

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أجريت تجربة حقلية في محطة بحوث رأس سدر جنوب سيناء حيث التربة جيرية رملية طميية وماء الري مالح خلال موسمي ١٩٩٩/٢٠٠٠ و ٢٠٠٠/٢٠٠١.

المعاملات ٢,٥، ٥ ،١٠و ١٥ مليمكافئ بيكربونات في اللتر وسماد مزرعة FYM بالمعدلات صفر ، ١٠و ٢٠ متر مكعب للفدان. أيضا الكبريت المعدني أضيف بالمعدلات ٠، ٢٥٠ و ٥٠٠ كجم للفدان وري التجربة بمعدل ٠,٥ متر مكعب للحوض (١/٤٠٠ فدان) والمحصول المنزرع قمح سخا ٨ واشتملت الدراسة على بعض التقديرات.

تتلخص فى الاتى :

١. إنتاجية الحبوب لمحصول القمح كانت أفضل معاملة OM_2S_2 $(HCO_3)_0$ لكن الأفضل من الناحية الاقتصادية كانت المعاملة OM_1S_2 $(HCO_3)_1$ حيث أن الفرق كان غير معنوي البيكربونات أكثر من المعاملة السابقة .

٢. إنتاجية القش : السماد العضوى والكبريت كان لهما تأثيرا معنويا وجيدا على إنتاجية القش حيث أفضل معاملة كانت OM_1S_2 $(HCO_3)_0$ لكن المعاملة الأفضل من الناحية الاقتصادية كانت $(HCO_3)_1$ OM_1S_2.

٣. المغذيات الصغرى الميسرة فى التربة (Fe, Mn and Zn) زادت مع زيادة السماد العضوى والكبريت وكانت أعلى قيم لهم فى معاملة OM_2S_2 تحت كل تركيزات البيكربونات فى ماء الرى المالح