

SOIL AMENDING AS A MANAGEMENT PRACTICE FOR MINIMIZING BICARBONATE HAZARD OF SALINE IRRIGATION WATER

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ABSTRACT

In order to evaluate the effect of bicarbonate ions in saline irrigation water in Ras Sudr Research Station where calcareous and sandy loam textured soil is dominant. Four levels of bicarbonate (initial level of well water 2.5, 5, 10, and 15 meqL⁻¹), different additions of farmyard manure (0, 10, and 20 m³ fed⁻¹) and three rates of sulphur (0, 250 and 500kg S fed⁻¹). The obtained data revealed that both soil EC and soil pH increased with increasing bicarbonate concentration more than 5 meqL⁻¹ in irrigation water. However soil EC and pH were decreased with increasing FYM and or sulphur rates. Soluble Na⁺ and K⁺ were increased with increasing HCO₃⁻ concentration, in irrigation water but soluble (Ca⁺⁺ & Mg⁺⁺) were lowest in case of (5 meqL⁻¹ HCO₃⁻). The effect of FYM and S were clear in case of OM₂S₂. The low value of soluble chloride occurred with adding 10 m³ fed⁻¹ under HCO₃⁻ rates 2.5 and 5 meqL⁻¹. Farmyard manure of 10 m³ fed⁻¹ was the best treatment, which improved the leaching of sulphate salts.

Keywords: Farmyard manure, calcareous soil, saline condition, South Sinai.

INTRODUCTION

In Egypt, calcareous soils comprise about 25 % of the newly reclaimed area. Because of the limited sources of water supply and the need urgent to expend the agricultural land, the use of saline water irrigation may arise as obligatory solution for such problem.

Karam (1999) evaluated the effects of saline irrigation water on soil salinity in experiment comprising clay and loamy soils. He used three different salinity levels. Under these conditions, the leaching fraction of 30 % through the low quality water consumption period, reduced the impacts of saline irrigation on both clay and loam soils.

Aziz *et al.*, (1998) found that soil conditioning markedly increased the amount of total soluble salts. Sodium and chloride ions showed highest values, while the lowest ones were for Mg⁺⁺ and K⁺. They added that

Soluble cations under the conditions of longer irrigation interval followed the order: Na⁺ > Ca⁺² > Mg⁺² > K⁺ and Cl⁻ > HCO₃⁻ > SO₄⁻².

EL-Maghraby (1997) reported that the results pertaining soil properties were affected by applying soil conditioners under 7 days' irrigation intervals. The soil pH, EC, SAR and ESP values were decreased with different magnitude under the conditioners treatments at any irrigation frequency. Also the waters table aggregates, soil moisture retention as measured at field capacity. While the bulk density decreased. Moreover, E L-Nabulsi (1998) showed that the EC_e and SAR increased noticeably as irrigation water salinity

increased, reducing the irrigation frequency prevented salt build up the soil. A direct positive relationship was observed also between water salinity and the leached fraction. The average soil EC_e in the 0-90 cm depth showed a distinct response to water salinity and irrigation frequency.

Also, FYM decomposition produces different acids which decrease soil pH. The lowest value in soluble Na^+ through bicarbonate concentration of 5 meq L^{-1} . The bicarbonate reduced plant yield:

- The adverse effect of HCO_3^- on plant metabolic processes.
- The disturbance on the plant nutrient balance.
- The excess of bicarbonate induced the dominance ions which react with soluble Zn^{+2} in soil. From the previous mentioned we must use soil conditioners example sulphur and farmyard manure in Egypt, calcareous soil represents 25 % of new reclaimed area.

El-Maghraby *et al.*, (1996) stated that grain and straw yields were significantly increased as result of adding sulphur and FYM the best treatment was 500kg fed^{-1} from sulphur.

Therefore, this study aims to evaluate the effects of wheat cultivation, different additions of farm yard manure and sulphur on some soil properties of calcareous soil at Ras Sudr, South Sinai, Egypt.

MATERIALS AND METHODS

A field experiment was carried out during (1999-2000) and (200-2001) growing seasons at Ras Sudr Experimental Station. Desert Research Center, South Sinai using wheat (Sakha 8). This field trial was arranged in a split-split plot design with four replicates for each treatment.

The bicarbonate levels in irrigation water at (2.5, 5, 10 and 15 meq L^{-1}) were in the main plots. Sub plots were occupied by 3 treatments of farmyard manure (control, 10 $m^3 fed^{-1}$ and 20 $m^3 fed^{-1}$). In addition, sub-sub plots were assigned by three rates of sulphur (0, 250 and 500 Kg S fed^{-1}).

The field experiment repeated for studding the response and residual effect through (2000-2001) growing season.

Soil analyses: Three soil samples representing three soil depths 0-15, 15 - 30 and 30 - 45 cm were taken (Tables 1 and 2). The mechanical analysis was carried out using the pipette method (Piper, 1950). O.M%, pH, EC dSm^{-1} , soluble cations and anions also ESP were determined in soil samples as described by 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 ⁺⁺ + Mg ⁺⁺	Na ⁺	K ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄ ⁻	
0-15	7.4	14.3	97.71	79.80	0.01	--	3.54	133.4	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 irrigation, EC, pH, and soluble cations and anions were determined as previously mentioned in soil extracts and are given in Table 3.

Table 3: Analysis 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 analysis of total N, C, P, K, Fe, Mn and Zn were determined according to Jackson(1967), Frie *et al.*, (1964) and Lindsay and Norvell (1978). The obtained data are given in Table 4.

Table 4: Analysis 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

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

The main effect of FYM rates on soil salinity regardless of sulfur, bicarbonate levels and soil depth show that EC values were decreased with increasing organic manure rates, generally the values of soil salinity of without organic manure application were relating greeting then that at FYM application either by OM1 or OM2 in both seasons (Table 5).

On the other hand, the main effect of sulphur level on soil salinity regard of OM, HCO₃⁻ levels, and soil depth show that the values of soil salinity were decreased with increasing sulphur levels in both seasons. However, the soil salinity values were increased with increasing bicarbonate levels.

In the first and second seasons, soil salinity decreased with increasing soil depth under any levels of FYM or sulphur and HCO₃⁻. In addition, increasing sulphur levels decreased soil salinity at any soil depths or any levels of FYM and HCO₃⁻. Meanwhile, soil salinity was increased with increasing FYM levels and bicarbonate at both soil depths.

It is worthy to note that the remarkable positive effect of either FYM or sulphur application was only occurred under 2.5 and 5 meqL⁻¹ HCO₃⁻ (first and second levels). This result may be attributed to the main effect of sulphur on soil pH during both seasons, especially at the 2nd rate (500kg fed⁻¹). This result could be supported by that obtained by Cifuentes *et al.* (1993).

The role of organic manure was enhancing the soil structure and leaching of soluble salts, while sulphur oxidation produces sulphate that reacts with Ca and consists gypsum which enhanced the soil structure and decreased soil pH too (Aziz *et al.*, 1998).

Table 5: EC (dSm⁻¹) values of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means	
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂		
First season (99-2000)														
S ₀	0-15	22.9	7.9	9.3	24.3	9.7	11.1	25.0	25.2	26.8	29.7	30.4	30.6	21.1
	15-30	19.3	7.4	8.0	22.0	8.8	10.5	23.6	24.8	25.9	28.6	28.6	30.0	19.8
S ₁	0-15	7.6	8.0	8.8	8.9	9.1	9.8	22.8	23.6	24.0	28.4	29.2	29.8	17.5
	15-30	7.3	7.4	7.6	8.5	8.7	8.9	20.6	21.9	23.2	27.8	28.2	29.2	16.6
S ₂	0-15	7.2	8.1	8.3	8.8	9.0	9.3	21.9	22.7	23.1	27.3	27.9	28.4	16.8
	15-30	6.7	7.6	7.7	8.4	8.6	8.0	21.6	21.9	22.2	26.4	27.1	27.8	16.2
Means		11.8	7.7	8.3	13.6	9.0	9.6	22.6	23.4	24.2	28.0	28.6	29.3	
		9.3			10.7			23.4			28.6			
18														
Second season (2000-2001)														
S ₀	0-15	25.2	11.2	12.4	26.8	13.1	14.5	27.9	28.2	29.7	31.9	33.7	34.1	24.1
	15-30	23.2	10.9	11.5	25.1	12.8	12.9	26.1	27.8	28.6	29.7	31.7	33.1	22.8
S ₁	0-15	10.4	11.6	12.3	13.2	13.8	13.9	25.9	27.2	28.4	30.3	32.4	33.7	21.1
	15-30	10.1	11.2	11.9	12.8	12.8	13.2	24.1	25.4	27.6	28.6	30.8	31.5	20.0
S ₂	0-15	10.1	11.4	11.9	12.7	13.9	14.3	24.6	25.3	26.5	29.4	30.2	31.8	20.2
	15-30	9.6	10.5	11.0	12.2	13.2	11.9	23.8	24.6	25.8	27.9	29.6	30.9	19.2
Means		14.8	11.1	11.8	17.1	13.3	13.5	26.4	26.4	27.7	29.6	31.4	32.6	
		12.6			14.6			26.6			31.2			
21.2														

The values of pH as affected by the treatment under consideration are given in Table 6. It is clear that, the soil pH values were not remarkably affected by the treatments. In the same time the values of the second season are greater than that obtained in case of the first season.

The bicarbonate application changed the soil initial soluble Na⁺ from 67.4 meqL⁻¹ to 75.6 and 198.5 meqL⁻¹ due to the three rates of applied HCO₃⁻, respectively in the 1st season (Table 7).

In the second season, the applied irrigation water which contains different levels of bicarbonates raised the general average of the soluble Na⁺ from 144.7 meqL⁻¹ to 158.15 meqL⁻¹.

Results reveal that, on average, sulphur application in the 1st growth season reduced the soluble Na⁺ seriously. The soluble Na⁺ reduced was more clear in the upper 0-15 cm soil layer as compared to the 15-30 cm soil layer. On average, the soluble Na⁺ values under S₀ treatment (166.5 meqL⁻¹) was reduced to 137.1 and 130.5 meqL⁻¹ with sulfur application at rates of 250 and 500 kg fed⁻¹, respectively. However, for the 2nd growth season there values were as, on average (180, 152 and 142.3 meqL⁻¹ for S₀, S₁ and S₂, respectively at the 2nd season while S fed⁻¹

respectively. Similar results were also obtained by El-Maghraby *et al.*, (1996) showed that the Na⁺ and S concentration were markedly affected by sulphur and organic manure applied singly or as combined treatments.

Table 6: The pH values of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means			
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂				
First season (99-2000)																
S ₀	0-15	7.48	7.38	7.31	7.55	7.51	7.47	7.62	7.59	7.48	7.71	7.67	7.55	7.53	7.50	
	15-30	7.38	7.31	7.30	7.49	7.46	7.41	7.57	7.52	7.43	7.70	7.61	7.51	7.47		
S ₁	0-15	7.37	7.30	7.28	7.48	7.46	7.45	7.58	7.55	7.45	7.59	7.65	7.53	7.47	7.45	
	15-30	7.32	7.27	7.25	7.45	7.41	7.40	7.53	7.51	7.41	7.52	7.61	7.51	7.43		
S ₂	0-15	7.33	7.27	7.24	7.44	7.40	7.39	7.57	7.53	7.41	7.55	7.63	7.48	7.44	7.41	
	15-30	7.25	7.21	7.20	7.39	7.37	7.33	7.51	7.48	7.37	7.46	7.58	7.48	7.38		
Means	7.30			7.44			7.50			7.58			7.46			
Second season (2000-2001)																
S ₀	0-15	8.28	8.20	8.13	8.43	8.38	8.33	8.86	8.81	8.76	9.35	9.03	8.78	8.61	8.54	
	15-30	8.18	8.15	8.02	8.34	8.22	8.21	8.77	8.64	8.58	9.22	8.81	8.56	8.47		
S ₁	0-15	8.17	8.11	8.00	8.41	8.28	8.25	8.66	8.64	8.61	9.27	8.97	8.53	8.49	8.43	
	15-30	8.11	8.01	7.75	8.33	8.19	8.18	8.52	8.51	8.43	9.18	8.84	8.42	8.37		
S ₂	0-15	8.11	8.01	7.89	8.34	8.16	8.10	8.51	8.46	8.34	9.15	9.02	8.89	8.42	8.39	
	15-30	8.00	8.00	7.81	8.25	8.04	8.00	8.46	8.37	8.24	9.10	9.10	8.85	8.35		
Means	8.14			8.08			8.25			8.57			12.02			9.23

Table 7: Soluble Na⁺ (meqL⁻¹) of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means			
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂				
First season(99-2000)																
S ₀	0-15	188.2	52.5	68.3	198.5	68.4	75.2	211.4	214.2	229.2	239.9	247.8	253.9	170.5	166.5	
	15-30	173.5	49.7	55.5	181.6	60.8	72.5	201.5	211.8	216.4	235.7	240.2	249.0	162.4		
S ₁	0-15	51.5	58.2	61.6	59.6	62.8	68.5	191.4	201.4	203.3	234.1	240.2	248.0	140.1	137.1	
	15-30	49.2	51.7	52.8	53.6	56.3	61.4	182.8	198.7	200.0	228.0	233.0	242.0	134.1		
S ₂	0-15	48.6	53.3	57.9	59.1	54.3	66.7	180.7	192.1	195.9	227.7	231.2	233.0	133.4	130.5	
	15-30	47.2	48.6	47.8	51.6	49.6	59.6	177.3	180.6	184.3	225.0	229.0	230.0	127.8		
Means	92.7			52.3			57.3			100.7			56.7			144.7
Second season(2000-2001)																
S ₀	0-15	193.3	75.9	87.9	200.4	89.7	110.5	226.5	229.7	240.5	250.4	258.6	268.9	186.0	180.0	
	15-30	184.8	66.7	75.6	189.8	78.6	100.7	210.7	210.4	231.9	238.4	247.4	253.4	174.0		
S ₁	0-15	68.4	74.4	81.4	76.8	77.9	83.2	201.5	213.4	218.7	247.3	254.6	259.6	154.6	152.0	
	15-30	62.3	73.5	75.8	72.1	73.5	78.5	197.6	209.4	211.3	241.2	248.6	248.8	149.4		
S ₂	0-15	57.6	63.5	75.4	67.4	69.5	74.4	191.3	204.5	209.4	231.6	244.3	246.1	144.6	142.3	
	15-30	53.4	60.4	72.4	66.9	64.5	71.5	188.4	194.5	196.7	229.1	241.0	240.5	139.9		
Means	103.0			69.1			78.1			112.2			75.6			158.15

Under bicarbonate application at rates 2.5, 5, 10 and 15 meqL⁻¹, the soluble K⁺ increased with increasing organic manure rates. The soluble K⁺ values under S₀ treatment (3.9 meqL⁻¹) increased to 5.4 and 5.7 meL⁻¹ with sulfur application at rates of S₁, S₂, respectively. Similar result was also obtained by El-Maghraby *et al.* (1996) (Table 8).

Table 8: Soluble K⁺ (meqL⁻¹) of the investigated soil after wheat harvesting.

	Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means	
		OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂		
First season(99-2000)															
S ₀	0-15	1.9	3.9	4.9	2.3	4.8	5.4	2.3	4.9	5.1	2.2	5.2	5.6	4.0	3.9
	15-30	1.8	3.5	4.6	1.9	4.5	5.1	2.0	4.9	4.8	2.0	4.9	5.6	3.8	
S ₁	0-15	4.6	5.2	6.7	4.9	5.5	6.3	4.8	5.3	5.9	5.3	5.7	5.9	5.5	5.4
	15-30	4.5	4.8	6.1	4.6	5.3	6.1	4.8	5.1	5.2	5.1	5.3	5.7	5.2	
S ₂	0-15	5.5	6.5	6.8	4.3	5.1	6.1	5.7	5.9	6.2	5.3	5.9	6.1	5.8	5.7
	15-30	5.3	6.4	6.5	4.1	4.8	5.6	5.4	5.6	6.1	5.1	5.6	5.9	5.6	
Means		3.9	5.1	5.9	3.7	5.0	5.8	4.2	5.3	5.6	4.2	5.4	5.8		5.0
		5.0			4.8			5.0			5.1				
Second season (2000-2001)															
S ₀	0-15	3.4	5.1	6.2	3.9	6.5	7.4	3.8	6.8	7.6	3.5	7.1	7.9	5.8	5.7
	15-30	3.2	4.8	6.0	3.6	6.3	7.2	3.6	6.6	7.5	3.5	6.8	7.6	5.6	
S ₁	0-15	5.5	6.4	7.6	5.9	6.4	7.1	5.6	5.9	6.4	6.5	6.9	7.4	6.5	6.4
	15-30	5.3	6.2	7.3	5.8	6.2	6.8	5.5	5.8	6.4	6.3	6.5	7.3	6.3	
S ₂	0-15	6.4	7.3	8.6	6.9	7.4	7.9	6.7	6.8	7.0	6.2	6.4	6.6	7.0	6.9
	15-30	6.3	7.2	8.4	6.7	7.3	7.8	6.4	6.5	6.8	6.0	6.1	6.5	6.8	
Means		5.0	6.2	7.4	5.5	6.7	7.4	5.3	6.4	7.0	5.3	6.6	7.2		6.3
		6.2			6.5			6.2			6.4				

The bicarbonate application treatments increased the soil initial soluble (Ca⁺⁺ + Mg⁺⁺) from 39.7 meqL⁻¹ to 49.0, 103.8 and 134.4 meqL⁻¹ due to the three rates of applied HCO₃⁻ respectively, at the 1st growth season (Table 9).

The soluble (Ca⁺⁺ + Mg⁺⁺) values were raised from 39.7, 49 to 103.8 and 134.4 meqL⁻¹ at the second growth season for the bicarbonate rates. The soluble (Ca⁺⁺ + Mg⁺⁺) was reduced from 63.5 meqL⁻¹ to 38 and 45.4 meqL⁻¹ with OM₁ and OM₂ treatments, respectively in case of HCO₃ (5 meqL⁻¹) treatment under bicarbonate application of (HCO₃)₂ and (HCO₃)₃ increased the soluble Ca⁺⁺ + Mg⁺⁺ under the OM₁ and OM₂ treatments. Result reveal that, on average, sulphur application at the 1st growth season reduced the soluble Ca⁺⁺ + Mg⁺⁺ seriously. The soluble Ca⁺⁺ + Mg⁺⁺ reduction was more clear in the upper 0 -15 soil layer and lower through the 15 -30 cm soil layer.

As for 2nd growth season, on average, the value of soluble Ca⁺⁺ + Mg⁺⁺ under S₀ treatment (106.1 meqL⁻¹) was reduced to 96 and 91.3 meqL⁻¹ with sulphur application at rates of S₁ and S₂ respectively. Similar results were also obtained by El-Maghraby *et al.* (1996).

The lowest values of soluble Ca⁺⁺ + Mg⁺⁺ were resulted from OM₁S₂ under bicarbonate of 5 meqL⁻¹ and the highest value was obtained with OM₂S₀ and bicarbonate of 15 meqL⁻¹ during both the 1st season and 2nd one.

Table 9: Soluble (Ca⁺⁺ + Mg⁺⁺) (meq L⁻¹) of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means		
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂			
First season(99-2000)															
S ₀	0-15	102.5	38.9	40.9	109.8	45.3	56.1	114.6	116.3	124.5	137.9	139.7	142.9	97.5	95.0
	15-30	101.9	28.9	33.9	106.4	41.6	51.7	105.6	113.0	118.1	133.7	135.9	139.2	92.5	
S ₁	0-15	28.3	32.2	38.8	43.2	38.2	44.9	97.6	107.1	110.2	133.9	138.4	140.5	79.4	77.1
	15-30	28.8	28.9	31.5	41.4	35.9	41.9	88.3	93.0	106.3	130.2	135.6	138.2	74.6	
S ₂	0-15	27.7	35.0	36.9	41.2	35.4	41.2	95.6	102.2	99.4	126.6	131.3	133.9	75.5	73.1
	15-30	21.7	31.4	28.3	38.7	31.7	36.8	82.3	98.5	96.4	123.4	127.1	130.4	70.6	
Means		51.5	32.6	35.1	63.5	38.0	45.4	97.3	105.0	109.2	131.0	134.7	137.5		
		39.7			49.0			103.8			134.4				
81.7															
Second season(2000-2001)															
S ₀	0-15	112.3	50.4	54.9	115.6	58.4	79.5	123.4	124.5	133.3	145.2	148.6	151.3	108.1	106.1
	15-30	109.5	41.3	56.8	110.2	51.6	73.9	119.8	121.3	130.5	141.6	143.8	147.6	104.0	
S ₁	0-15	55.3	61.5	67.5	70.5	72.5	75.4	100.4	115.1	121.3	146.2	147.5	151.3	98.7	96.0
	15-30	51.4	55.6	62.4	62.5	67.4	69.3	94.6	109.6	116.5	141.3	142.6	145.8	93.3	
S ₂	0-15	47.6	60.4	65.4	69.7	71.8	73.6	93.5	109.5	110.5	138.7	140.6	146.7	94.0	91.3
	15-30	45.6	54.2	60.7	61.8	66.3	68.8	87.6	101.2	105.4	132.4	136.7	142.6	88.6	
Means		70.3	53.9	61.3	81.7	64.7	73.4	103.2	113.5	119.6	140.9	143.3	147.6		
		61.8			73.3			112.1			143.9				
97.8															

The best treatments were OM₂S₁ at 2.5 meqL⁻¹ bicarbonate in irrigation water followed by OM₂S₂ at 5 meqL⁻¹ bicarbonate concentrations (Table 10).

Table 10: Soluble HCO₃⁻ (meqL⁻¹) of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₀			(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			Means		
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂			
First season(99-2000)															
S ₀	0-15	2.9	2.5	2.3	6.5	5.5	4.8	10.9	8.9	7.9	16.7	13.9	12.8	8.0	7.9
	15-30	2.8	2.4	2.2	6.3	5.5	4.6	10.7	8.7	7.9	16.3	13.6	12.7	7.8	
S ₁	0-15	2.5	2.3	2.1	4.8	4.6	4.5	8.5	7.7	6.9	11.7	10.9	10.5	6.4	6.4
	15-30	2.4	2.1	2.1	4.7	4.5	4.3	8.3	7.4	6.7	11.6	10.7	10.5	6.3	
S ₂	0-15	2.2	2.1	2.3	5.1	4.8	3.9	6.8	6.9	6.5	9.7	9.7	8.8	5.7	5.7
	15-30	2.3	2.1	2.0	4.8	4.2	3.7	6.7	6.7	6.2	9.7	9.5	8.8	5.6	
Means		2.5	2.3	2.2	5.4	4.9	4.3	8.7	7.7	7.0	12.6	11.4	10.7		
		2.3			4.9			7.8			11.6				
6.7															
Second season(2000-2001)															
S ₀	0-15	3.8	3.6	3.4	7.8	7.5	7.3	12.1	11.8	11.6	18.5	18.1	17.7	10.3	10.2
	15-30	3.7	3.5	3.2	7.6	7.4	7.2	11.8	11.6	11.3	18.3	17.8	17.5	10.1	
S ₁	0-15	3.2	3.1	3.0	7.7	7.6	7.4	10.6	10.3	10.1	15.7	15.5	15.2	9.1	9.1
	15-30	3.2	3.0	2.9	7.6	7.5	7.3	10.4	10.2	9.9	15.4	15.3	15.0	9.0	
S ₂	0-15	2.8	2.9	2.8	7.4	7.3	7.2	9.8	9.6	9.3	14.6	14.4	14.3	8.5	8.4
	15-30	2.6	2.8	2.7	7.3	7.1	7.0	9.6	9.3	9.1	14.3	14.2	14.1	8.3	
Means		3.2	3.2	3.0	7.6	7.4	7.2	10.7	10.5	10.2	16.1	15.9	15.6		
		3.1			7.4			10.5			15.9				
9.2															

The best treatment of organic manure with respect to Cl⁻ concentration was that of 10 m³ fed⁻¹. Under all the added bicarbonate concentrations but the 20 m³ fed⁻¹ rate was of the best one. However added S up to 500 kg fed⁻¹ decreased the soil chloride concentration and the best treatment was OM₁S₂ under all treatments of bicarbonate (Table 11).

Table 11: Soluble Cl⁻ (meqL⁻¹) of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			(HCO ₃) ₄			Means	
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂		
First season(99-2000)														
S ₀	0-15	267	79	85	282	93	99	302	314	330	364	372	379	247.2
	15-30	261	77	83	278	91	96	284	309	327	361	368	375	242.5
S ₁	0-15	62	57	69	92	93	85	277	280	288	360	366	371	200.8
	15-30	57	56	68	88	88	91	271	271	285	355	362	368	196.7
S ₂	0-15	59	60	71	90	91	93	265	273	278	340	349	357	193.8
	15-30	58	58	67	88	86	91	260	271	275	335	346	351	190.5
Means		127.3	64.5	73.8	153	90.33	94.167	276.5	286.3	297.2	352.5	360.5	366.8	
		88.54			112.5			286.7			359.9			
211.9														
Second season(2000-2001)														
S ₀	0-15	271.0	83.0	86.0	279.0	96.0	102.0	308.0	318.0	335.0	369.0	375.0	381.0	250.3
	15-30	268.0	81.0	83.0	273.0	93.0	98.0	301.0	311.0	330.0	364.0	371.0	377.0	245.8
S ₁	0-15	67.0	70.0	72.0	94.0	76.0	77.0	281.0	283.0	289.0	363.0	367.0	372.0	200.9
	15-30	65.0	68.0	71.0	91.0	75.0	75.0	278.0	280.0	286.0	361.0	364.0	368.0	198.5
S ₂	0-15	62.0	64.0	67.0	91.0	72.0	74.0	267.0	268.0	270.0	342.0	351.0	358.0	190.5
	15-30	62.0	63.0	65.0	89.0	70.0	72.0	265.0	266.0	265.0	337.0	346.0	355.0	187.9
Means		132.5	71.5	74.0	152.8	80.3	83.0	283.3	287.7	295.8	356.0	362.3	368.5	
		92.7			105.4			288.9			362.3			
212.3														

The rate of 10 m³ fed⁻¹ FYM was the best treatment, inducing the leaching of sulfate salts. On the other hand, organic manure at the rate of 20 m³ fed⁻¹ increased the soluble sulfate. The best treatment was OM₁S₂ under all the treatments of bicarbonate concentration (Table 12).

Table 12: Soluble SO₄⁻ (meqL⁻¹) of the investigated soil after wheat harvesting.

Soil depth	(HCO ₃) ₁			(HCO ₃) ₂			(HCO ₃) ₃			(HCO ₃) ₄			Means	
	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂	OM ₀	OM ₁	OM ₂		
First season (99-2000)														
S ₀	0-15	24.3	9.8	18.9	11.5	12.5	13.6	12.8	12.9	13.9	13.3	13.9	14.3	14.1
	15-30	23.9	9.5	18.1	11.1	12.5	12.5	12.7	13.4	12.9	13.0	14.1	13.9	14.1
S ₁	0-15	18.9	19.5	20.6	12.5	13.7	14.6	13.1	15.1	15.8	13.8	14.4	15.7	15.6
	15-30	18.3	19.2	20.2	11.9	12.9	13.5	12.8	14.8	15.5	13.4	14.1	15.1	15.1
S ₂	0-15	20.9	21.4	21.9	13.1	14.8	15.6	15.3	16.4	17.3	16.9	17.3	17.8	17.4
	15-30	20.5	21.1	21.7	12.8	14.3	15.2	15.0	16.1	17.1	16.5	17.1	17.5	17.1
Means		21.1	16.8	20.2	12.2	13.5	14.2	13.6	14.7	15.5	14.5	15.0	15.8	
		19.4			13.3			14.6			15.1			
15.6														
Second season (2000-2001)														
S ₀	0-15	20.6	11.9	20.3	13.7	13.4	15.8	14.6	14.9	15.7	15.9	16.7	16.9	15.9
	15-30	20.4	11.3	20.1	13.4	13.1	15.4	14.3	14.5	15.3	15.4	16.3	16.4	15.5
S ₁	0-15	22.3	21.2	21.9	14.3	14.8	15.4	17.6	18.1	18.8	19.8	20.7	21.3	18.9
	15-30	22.1	20.9	21.7	14.2	14.5	15.3	17.3	17.8	18.5	19.6	20.4	21.0	18.6
S ₂	0-15	28.8	23.5	24.1	15.6	16.3	16.8	17.4	17.6	17.9	18.3	18.7	19.4	19.4
	15-30	25.4	23.1	23.8	15.3	16.1	16.4	17.1	17.4	17.5	18.0	18.4	19.2	19.0
Means		22.9	18.7	22.0	14.4	14.7	15.9	16.4	16.7	17.3	17.8	18.5	19.0	
		21.2			15			16.8			18.4			
17.9														

Conclusion

In conclusion, FYM and S tended to reduce the values of soil EC and pH. The soluble Na^+ , K^+ and $(\text{Ca}^{++} + \text{Mg}^{++})$ were increased with increasing HCO_3^- when the HCO_3^- was more than 5 meqL^{-1} , but organic manure and sulphure reduced soluble Na^+ , Ca^+ and Mg^{++} on contrast raised soluble K^+ . The effect of S as soluble anions was better than FYM. The best combined treatment in case of OM_1 , OM_2 and OM_3 , respectively.

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استخدام مصلحات التربة كإحدى عمليات الخدمة للحد من مخاطر البيكربونات فى ماء الري

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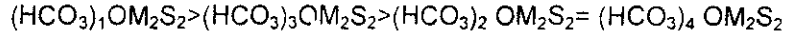
أجريت هذه الدراسة لتقييم تأثير أيون البيكربونات فى ماء الري المالح على مسافات التربة وعلاقته بإضافة الكبريت والمادة العضوية حيث جمعت عينات التربة على أعماق من صفر - ١٥سم و ٣٠-٤٥سم فى محطة تجارب راس سدر جنوب سيناء لتمثل أراضي جيرية وطميية رمليسة متساثرة بالأملاح تحت ظروف الري المالح واشتملت الدراسة على بعض التغييرات الهامة التى يمكن تلخيصها فى الآتى:

١- التوصيل الكهربى: ازداد فى الطبقة السطحية وانخفض مع زيادة معدل اضافة المادة العضوية والكبريت.

٢- رقم حموضة التربة عند أكسدة الكبريت ينتج عنها كبريتات التى تخفض رقم حموضة التربة وتحلل المادة العضوية ينتج عنها أحماض مختلفة والتى بدورها تخفض رقم حموضة التربة.

٣- الصوديوم الذائب فى التربة: انخفضت قيمة الصوديوم الذائب الى اقل قيمة لها تحت تأثير المعاملة OM_1S_0 $(HCO_3)_1$ يليها المعاملة OM_2S_2 $(HCO_3)_1$ بينما انخفضت قيمة الصوديوم الذائب فى المعاملة OM_1S_2 $(HCO_3)_2$ الى اقل قيمة عند ما كان تركيز البيكربونات ٥ ملليمكافى /لتر وانخفض تأثير المادة العضوية والكبريت الى اقل قيمة على الصوديوم الذائب خلال تركيز بيكربونات ١٠ ملليمكافى/لتر و ١٥ ملليمكافى /لتر.

٤- البوتاسيوم الذائب فى التربة: أدت زيادة معدل اضافة المادة العضوية والكبريت الى زيادة قيمة البوتاسيوم الذائب حيث سجلت أعلى قيمة له فى حالة المعاملة OM_2S_2 تحت تركيز بيكربونات ٢,٥ ملليمكافى /لتر. أخذت تركيزات البوتاسيوم الترتيب التالى:



٥- الكالسيوم والماغسيوم: الذائب فى التربة نتيجة للتأثير المحسن للمادة العضوية والكبريت انخفض الكالسيوم والماغسيوم الذائب خاصة فى حالة معاملة المقارنة ٢,٥ ملليمكافى/لتر ٥ ملليمكافى /لتر بيكربونات مع زيادة البيكربونات حتى ١٠ ، ١٥ ملليمكافى/لتر انخفض التأثير الجيد للمادة العضوية والكبريت لان أملاح البيكربونات تحتوى على الكالسيوم والماغسيوم

٦- البيكربونات الذائبة فى التربة: أفضل معاملة كانت OM_2S_1 عند الكنترول ٢,٥ ملليمكافى /لتر، OM_2S_2 عند ٥ و ١٠ و ١٥ ملليمكافى/لتر كان تأثير الكبريت أكثر وضوحا مقارنة بالمادة العضوية

٧- الكلوريد الذائب فى التربة: المعاملة الأفضل للمادة العضوية كانت ١٠م^٣/فدان عند كل معاملات الكربونات ولكن معاملة ٢٠م^٣/فدان كانت اعلى فى الكلوريد لان المادة العضوية تحتوى على كلوريد. الكبريت نقص من تركيز الكلوريد مع زيادة معدلات الكبريت حتى ٥٠٠كجم/فدان، المعاملة الأفضل كانت OM_1S_2 تحت كل معاملات البيكربونات

٨- الكبريتات الذائبة فى التربة: معدل ١٠م^٣/فدان مادة عضوية كان الأفضل الذى حسن الغسيل لأملاح الكبريتات من ناحية اخرى معدل ٢٠م^٣/فدان من المادة العضوية أدى الى زيادة الكبريتات الذائبة لان المادة العضوية تحتوى على كبريتات، المعاملة الأفضل كانت OM_1S_1 فى كل معاملات البيكربونات.