*J. Agric. Sci. Mansoura Univ., 33 (5): 3895 - 3904, 2008*

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

**Abdel-Aal, R. S. *; M. D. Alaga **; A. H. Abd El-Hamid** and A. A. Mousa****

*** Soil Sci. Dept., Faculty of Agric., Moshtohor, Benha Univ., Egypt**
****Soil Conservation. Dept., Desert Res. Centre Cairo, Egypt**

## 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 meq$L^{-1}$), different additions of farmyard manure (0,10, and 20 $m^3$ $fed^{-1}$) 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 meq$L^{-1}$ 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 $HCO_3^-$ concentration, in irrigation water but soluble ($Ca^{++}$ & $Mg^{++}$) were lowest in case of (5 meq$L^{-1}$ $HCO_3^-$). The effect of FYM and S were clear in case of $OM_2$ $S_2$. The low value of soluble chloride occurred with adding 10 $m^3$ $fed^{-1}$under $HCO_3^-$ rates 2.5 and 5 meq$L^{-1}$. Farmyard manure of 10 $m^3$ $fed^{-1}$ was the best treatment, which improved the leaching of sulphate salts.

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

## INTRODUTION

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 $Cl^- > HCO_3^- > SO4^{-2}$.

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, EL-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:

a. The adverse effect of $HCO_3^-$ on plant metabolic processes.
b. The disturbance on the plant nutrient balance.
c. 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 and15 $meqL^{-1}$) were in the main plots. Sub plots were occupied by 3 treatments of farmyard manure (control, $10m^3fed^{-1}$ and $20m^3fed^{-1}$). 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 1and 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $Ca^{+2}$ + $Mg^{+2}$ | $Na^+$ | $K^+$ | $CO_3^=$ | $HCO_3^-$ | $Cl^-$ | $SO_4^=$ | |
| 0-15 | 7.4 | 14.3 | 97.71 | 79.80 | 0.01 | -- | 3.54 | 133.4 | 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 OM1or OM2 in both seasons (Table 5).

On the other hand, the main effect of sulphur level on soil salinity regard of OM, $HCO_3^-$ levels, and soil depth show that the values of soil salinity were decreased with increasing sulpher 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 $HCO_3^-$. In addition, increasing sulphur levels decreased soil salinity at any soil depths or any levels of FYM and $HCO_3^-$. 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 meq$L^{-1}$ $HCO_3^-$ (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** | **20.4** | **18** |
| | 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** | **17.1** | |
| | 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** | **16.5** | |
| | 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** | **13.5** | **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** | **23.5** | **21.3** |
| | 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** | **20.5** | |
| | 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** | **19.8** | |
| | 15-30 | 9.6 | 10.5 | 11.0 | 12.2 | 13.2 | 11.9 | 23.8 | 24.6 | 25.6 | 27.9 | 29.6 | 30.9 | **19.2** | | |
| Means | | **14.8** | **11.1** | **11.8** | **17.1** | **13.3** | **13.5** | **25.4** | **26.4** | **27.7** | **29.6** | **31.4** | **32.5** | | | |
| | | **12.6** | | | **14.6** | | | **26.5** | | | **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 meq$L^{-1}$ to 75.6 and 198.5 meq$L^{-1}$ due to the three rates of applied $HCO_3^-$, 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 144.7meq$L^{-1}$ to 158.15 meq$L^{-1}$.

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 $S_0$ treatment (166.5 meq$L^{-1}$) was reduced to 137.1 and 130.5 meq$L^{-1}$ 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 meq$L^{-1}$ for $S_0$, $S_1$ and $S_2$, 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 | 7.45 |
| | 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 | 7.46 | 7.38 | | |
| Means | | 7.36 | 7.29 | 7.26 | 7.47 | 7.44 | 7.41 | 7.56 | 7.53 | 7.43 | 7.59 | 7.63 | 7.51 | | | |
| | | 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 | 8.45 |
| | 15-30 | 8.18 | 8.15 | 8.02 | 8.34 | 8.22 | 8.21 | 8.77 | 8.64 | 8.56 | 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 | 8.16 | 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 | 7.93 | 8.35 | 8.21 | 8.18 | 8.63 | 8.57 | 8.49 | 9.21 | 8.96 | 8.67 | | | |
| | | 8.06 | | | 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 | 186.2 | 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 | 144.7 |
| | 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 | 127.6 | | |
| Means | | 92.7 | 52.3 | 57.3 | 100.7 | 58.7 | 67.3 | 190.9 | 199.8 | 204.9 | 231.7 | 236.9 | 242.7 | | | |
| | | 67.4 | | | 75.6 | | | 198.5 | | | 237.1 | | | | | |
| | | 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 | 158.1 |
| | 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 | 66.4 | 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 | 86.5 | 202.7 | 210.3 | 218.1 | 239.7 | 249.1 | 252.9 | | | |
| | | 83.4 | | | 91.5 | | | 210.4 | | | 247.3 | | | | | |
| | | 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 $S_0$ treatment (3.9 $meqL^{-1}$) increased to 5.4 and 5.7 $meL^{-1}$ with sulfur application at rates of $S_1$, $S_2$, respectively. Similar result was also obtained by El-Maghraby *et al.* (1996) (Table 8).

**Table 8: Soluble $K^+$ ($meqL^{-1}$) of the investigeted 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 | 5.0 |
| | 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 | 5.8 | 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 | | | 4.8 | | | 5.0 | | | 5.1 | | | | | |
| | | 5.0 | | | | | | | | | | | | | | |
| | | 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 | 6.3 |
| | 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 | | | |
| | | 6.2 | | | 6.5 | | | 6.2 | | | 6.4 | | | | | |
| | | 6.3 | | | | | | | | | | | | | | |

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 $HCO_3^-$ 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 $OM_1$ and $OM_2$ treatments, respectively in case of $HCO_3$ (5 $meqL^{-1}$) treatment under bicarbonate application of $(HCO_3)_2$ and $(HCO_3)_3$ increased the soluble $Ca^{++}$ + $Mg^{++}$ under the $OM_1$ and $OM_2$ 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 $S_0$ treatment (106.1 $meqL^{-1}$ ) was reduced to 96 and 91.3 $meqL^{-1}$ with sulphur application at rates of $S_1$ and $S_2$ respectively. Similar results were also obtained by El-Maghraby *et al.* (1996).

The lowest values of soluble $Ca^{++}$ + $Mg^{++}$ were resulted from $OM_1S_2$ under bicarbonate of 5 $meqL^{-1}$ and the highest value was obtained with $OM_2S_0$ 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 | 81.7 |
| | 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 | 26.8 | 28.9 | 31.5 | 41.4 | 35.9 | 41.9 | 88.3 | 93.0 | 106.3 | 130.2 | 135.6 | 138.2 | 74.8 | | |
| $S_2$ | 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 | 97.8 |
| | 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 $OM_2S_1$ at 2.5 meq$L^{-1}$ bicarbonate in irrigation water followed by $OM_2S_2$ at 5 meq$L^{-1}$ bicarbonate concentrations (Table 10).

**Table 10: Soluble $HCO_3^-$ (meq$L^{-1}$) 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 | 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 | 6.7 |
| | 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 | 11.5 | 18.5 | 18.1 | 17.7 | 10.3 | 10.2 | 9.2 |
| | 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 $m^3$ $fed^{-1}$. Under all the added bicarbonate concentrations but the 20 $m^3$ $fed^{-1}$ 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 $OM_1S_2$ 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 | 244.85 | 211.9 |
| | 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 | 95 | 277 | 280 | 288 | 360 | 366 | 371 | 200.8 | 198.8 | |
| | 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 | 192.15 | |
| | 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 | 248.1 | 212.3 |
| | 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 | 199.7 | |
| | 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 | 189.2 | |
| | 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 $m^3$ $fed^{-1}$ FYM was the best treatment, inducing the leaching of sulfate salts. On the other hand, organic manure at the rate of 20 $m^3$ $fed^{-1}$ increased the soluble sulfate. The best treatment was $OM_1S_2$ under all the treatments of bicarbonate concentration (Table 12).

**Table 12: Soluble $SO_4^{--}$ ($meqL^{-1}$) 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 | 14.3 | 14.1 | 15.6 |
| | 15-30 | 23.9 | 9.5 | 18.1 | 11.1 | 12.5 | 12.5 | 12.5 | 12.7 | 13.4 | 12.9 | 13.0 | 14.1 | 13.9 | | |
| $S_1$ | 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 | 15.4 | |
| | 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 | 17.3 | |
| | 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 | 15.7 | 17.9 |
| | 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 | 18.8 | |
| | 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 | 26.6 | 23.5 | 24.1 | 15.6 | 16.3 | 16.8 | 17.4 | 17.6 | 17.9 | 18.3 | 18.7 | 19.4 | 19.4 | 19.2 | |
| | 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 ($Ca^{++}$ + $Mg^{++}$) 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.

## REFERENCES


Aziz, M. A., M. F. A. Sallam, A. M. El-Gendy and M.A. El-Moniem (1998). Effect of natural soil conditioners and irrigation conditions on some chemical properties of sandy soils of Inshas and cucumber yield.Egyptian Journal of Soil Science. 38:1-4, 377-411.

Chapman, H. D and D. F. Pratt (1961). Methods of Analysis for Soil. Plants and Water. Univ. of California, Division of Agric. Sciences.

Cifuentes, F. R and W. C. Lindemann (1993). Organic matter stimulation of elemental sulfur oxidation in a calcareous soil. Soil Science Society of America Journal. 57: (3) 727-731.

El-Maghraby, S. E. (1997). Impact of natural conditioners and saline irrigation water frequency on calcareous soil productivity. Egypt Soil Sci. 37:267-281.

El-Maghraby, S. E. F. A. Hashem and M. M. Wassif (1996). The use of sulphur and organic manure for controlling soil salinity pollution under high saline water irrigation. Egyptian Journal of Soil Science. 36:1-4, 269-288.

El-Nabulsi, Y. A. (1998). Effect of saline water irrigation frequency and Crop on some soil chemical properties. Alxandria J. Agric. Res. 43: 255-265.

FAO (1985). Water Quality for Agriculture. Ayers R. S. and Westcott D. W. (Ed) irrigation and drainage. Paper 29, Rev. 1, FAO, Rome.

Frie, E.; K. Peyer and E. Schutg (1964). Determination of phosphorus by ascorbic acid. Schw. Lndwirtschaft, For Schung Heft. 3: 318-328.

Jackson, M. L. (1967). Soil Chemical Analysis Constable & Co., Ltd., London.

Karam, F. (1999). The effect of saline irrigation water on sunflower production: assessment of leaching fraction for the control of root zone salinity. Irrigation management and saline condition. Proceedings of Regional Symposium. JUST, Irbid, Jordan, June. 98-107.

Lindsay and Norvell (1978). Development of a DTPA soil test for Fe, Mn, Zn and Cu. Soil Sci. Amer. Proc. 42:421-428.

Gomez, K. A. and A. A. Gomez (1984). "Statistical Procedures for Agricultural Research". 2nd Ed. John Wiely and Sons New York, pp. 680.Inc.

Piper, G. S. (1950). Soil and Plant Analysis. Interscience Publishers, Inc., New York.

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

**رأفت سرور عبد العال * ، محمود ضياء الدين الأجه ** ، على عبد الحميد** و عزمي عبد الله محمد موسى****

*** قسم الأراضي ، كلية الزراعة بمشتهر- جامعة بنها - مصر**

**** قسم صيانة الأراضي - مركز بحوث الصحراء – القاهرة- مصر**

أجريت هذه الدراسة لتقييم تأثير ايون البيكربونات فى ماء الرى المالح على صفات التربة وعلاقتة بإضافة الكبريت والمادة العضوية حيث جمعت عينات التربة على أعماق من صفر -١٥سم و ١٥-٣٠سم و ٣٠-٤٥سم فى محطة تجارب راس سدر جنوب سيناء لتمثل أراضى جيرية وطميية رملية متاثرة بالاملاح تحت ظروف الرى المالح واشتملت الدراسة على بعض التغيرات الهامة التى يمكن تلخيصها فى الاتى:

١- التوصيل الكهربي: 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 مليمكافى /لتر وانخفض تأثير المادة العضوية والكبريت الى اقل قيمة على الصوديوم الذائب خلال تركيز بيكربونات ١٠مليمكافئ/لتر و١٥مليمكافئ /لتر.

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

$$(HCO_3)_1OM_2S_2>(HCO_3)_3OM_2S_2>(HCO_3)_2\,OM_2S_2=(HCO_3)_4\,OM_2S_2$$

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

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

٧- الكلوريد الذائب فى التربة: المعاملة الأفضل للمادة العضوية كانت ١٠م٣/فدان عند كل معاملات الكربونات ولكن معاملة ٢٠م٣/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 ١٠م٣/فدان مادة عضوية كان الافضل الذى حسن الغسيل لاملاح الكبريتات' من ناحية اخرى معدل ٢٠م٣/فدان من المادة العضوية ادى الى زيادة الكبريتات الذائبة لان المادة العضوية تحتوى على كبريتات، المعاملة الأفضل كانت OM1S1 فى كل معاملات البيكربونات.