# Journal of Soil Sciences and Agricultural Engineering

**Journal homepage & Available online at: www.jssae.journals.ekb.eg**


# Effect of Irrigation with Low Quality Water on the Efficiency of Agricultural Gypsum in Sodic Soils


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## ABSTRACT

Columns experiment was constructed on the farm of Agriculture College, Al-Azhar University to study the efficiency of agricultural gypsum in improving the chemical properties of alkaline clay soils (El -Salam Canal project soil) which irrigated with agricultural drainage water. Soil samples were taken from the research region; they were prepared then mixed with agricultural gypsum GR. The treatments were watering with varying quality having different values of SAR. The experiment consisted of 15 columns comprised five treatments in three replicates completely randomized design. Plastic columns with the diameter of 15 cm and 45 cm length and tatted with a slot at the bottom so that drained water are collected regularly during the probationary period for the purpose to track the change in some chemical properties such as EC and pH. The results showed an increase in the values of pH, EC in treatments that contain high concentration of sodium used for irrigation, which led to a decrease in the efficiency of agricultural gypsum through the soil column of experiment compared to the control. The results also showed a linear relationship between SAR and ESP. The obtained linear equation was ESP = 1.0148 SAR+ 6.0165 where R2 = 0.831. It was also found that, by increasing the SAR values in irrigation water, the efficiency of agricultural gypsum decreased. Therefore, it could be recommended adjusting the amount of added agricultural gypsum to soils irrigated with water with high contents of sodium to prevent sodium accumulation in root zone.



***Keywords***: Sodic soil, low-quality water, gypsum.


## INTRODUCTION

Sodic soil is one of the forms of salt affected soils which pose a major issue for crop production due to physical and chemical properties degradation. Reclamation and improvement of these soils requires replacement of exchangeable sodium on exchange complex by calcium ions to the desired level. Irrigation with low-quality water is one of the main causes of soil salinization, affecting all soil properties as well as affects the efficiency of added fertilizers and the amendments. This research was conducted to try to study the efficiency of agricultural gypsum added to improve the alkaline soil properties and the extent of the effect of low-quality water on it. In Egypt, salt-affected soils represent around 30% of the total agricultural area (FAO, 2005). The soil that received gypsum at higher rate removed the greatest amount of $Na^+$ from the soil columns and caused substantial decrease in soil electrical conductivity EC and sodium adsorption ration SAR (Hamza and Anderson, 2003). Poor drainage and reuse of low-quality water supports the increase of sodium and salinity (Mohamed ,2017). The accumulation of salt resulting from using low-quality water in the root zone was an important factor in reducing the yield (Al-Omran, et al., 2010). The accumulation of excessive salt in irrigated soil reduces crops yields, leads to ruin soil structure and affects other soil properties (Hornick, et al., 2007). Saline groundwater and poor drainage conditions are a constant factor causing salinity resulting in poor productivity (Moukhtar, et al., 2003). Accumulation of salts in soils changes its physical and chemical properties, including pH and raises ESP values, electrical conductivity, sodium absorption ratio SAR, saturated hydraulic conductivity and soil available water capacity AWC. Consequently, mineral elements and water availability for plant growth and yield of most crops are affected (Al-Busaidi and Cooksen, 2003). Saline soils properties can be improved by draining excess water out of the root zone to reduce soluble salts. However, improving the characteristics of such saline - sodic soils needs the removal of sodium ($Na^+$) from the soil, which can be accomplished by adding soluble calcium ($Ca^{2+}$) salts, such as gypsum, and then leaching and expelling the exchanged sodium from the root zones. (Khosla, et al., 1979). Gypsum especially improves both chemical and physical properties of heavy clay and sodic soils (Chen and Dick, 2011). Gypsum is frequently used to restore saline-sodic and sodic soils. Because of its solubility, low cost, availability, and ease of handling, it is the most commonly used additive in agricultural areas for sodic soil reclamation and reducing the negative effects of high sodium irrigation water. (Amezketa, et al., 2005). $Ca^{2+}$ additions can increase the diversity of soil qualities and act as soil modifiers, reducing the possibility of sodicity, which is related to plant growth, agricultural productivity, and crop productivity. (Wong, et al., 2009) and (Chintala, et al., 2010). Gypsum plays a significant role in the reclamation of saline-sodic soils by providing a $Ca^{2+}$ cation to replace the exchangeable $Na^+$ from the colloid's cation exchange positions and leaching $Na^+$ out from the root zone into groundwater (Sharma and Minhas, 2005). The application of gypsum resulted in a considerable increase in $Ca^{+2}$and $Mg^{+2}$ concentrations in saline and sodic clay soils, and improve chemical properties of soil in respect of $Na^+$ salts release and reduce electrical conductivity, and led to increase rice growth and yield, so gypsum is considered to


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**DOI: 10.21608/jssae.2022.128264.1069**

be one of the best effective soluble salt filtration treatments to reclaim saline and sodic clay soils and increase the efficiency of water use, plant growth, and yield of rice (Hafez, et al., 2015). Considered gypsum as an effective soil amendment to reclaim sodic soils of poor aggregation (soil structure) (Fisher, 2011). Irrigation with low-quality water for long periods without adding amendments to the soil, such as agricultural gypsum, can deteriorate the properties of soil, whether chemical and physical, as the pH values, ESP increased and soil permeability decreased compared to the soils that were treated with agricultural gypsum and organic amendments(Choudhary, et al., 2011). Improving the properties of soils irrigated with low-quality water needs to be treated with gypsum as a source of $Ca^{2+}$, which removes excess $Na^{+}$ from the exchange complex and improves the soil suitable for root growth and water and nutrient uptake by plants (Qadir, et al., 2007). (Zare ,et al., 2014) proved that, there is a linear relationship between (ESP) measured and calculated based on soils water SAR and that the correlation coefficient between them ( $R^2$ =0.806), this linear relationship states the following :- ESP=0.941+1.119 SAR , they are tested the significant differences between the two values with the paired samples T-test, the results indicated that there are no differences between the soil ESP values predicted by the model and the measured by laboratory tests, whereas no significant statistical differences were found at ($P > 0.05$). So they are recommended that the ESP-SAR soil model can provide a simple and direct, cost-effective, and concise method for evaluating soil ESP. According to (Chaudhry, 2001) the performance of agricultural gypsum as an amendment varies in the reclamation of alkaline soils depending on soil texture, how gypsum applied, gypsum purity, and gypsum mixing ratio with other adjustments. Moreover, it is also affected by the other treatments. (Ezeaku, et al., 2015) found that application of soil reclamation treatments especially gypsum at 100% GR and in combination with other organic amendments decreased soil pH. (Siosemarde, et al., 2010), concluded that by using a linear regression model that depends on the soil SAR ratio to predict the soil exchange sodium ratio (ESP) .The laboratory-estimated soil ESP values were compared with the predicted soil ESP values using the model. The results of the paired samples T-test indicated that the difference between the laboratory-estimated soil ESP values and those predicted by the model did not show significant differences ($P > 0.05$). Therefore, the equation for calculating soil ESP with SAR values can provide an easy, economical and concise methodology for estimating ESP.

**The purposes of the present work were:**

1. Studying the relationship between irrigation water quality and its effect on the efficiency of agricultural gypsum in reducing soil alkalinity values.
2. Trying to modify the quantities of gypsum that are added to the soil (GR) to reduce the values of ESP when using low quality water based on the linear equations that link between SAR and ESP.

## MATERIALS AND METHODS

### 1- Description of the study area and the experiment

**Study area:**

The study area is in El-Salam Canal Project, south of Port Said Governorate - Egypt. As shown in figure (No 1)

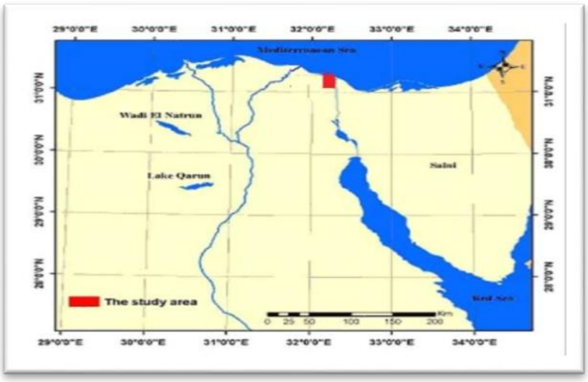


**Fig. 1. General map of study area**

Samples were collected from study area and air dried, crushed and sieved through a 2-mm Sieve and prepared to analyze its chemical and physical properties (Table 1).

**Table 1. Some Physical and chemical properties of studied soil.**

| Property | | | Value |
|---|---|---|---|
| Particle size distribution, % | | Sand | 19.3 |
| | | Silt | 22.6 |
| | | clay | 58.1 |
| Textural class | | | clay |
| Soil moisture characteristics [%] | | S.P | 67.5 |
| | | F.C | 33.8 |
| | | W.P | 16.9 |
| Density, porosity and hydraulic conductivity | | Bulk density [g.cm$^{-3}$] | 1.53 |
| | | Total porosity [%] | 42.26 |
| | | Hydraulic conductivity cm h$^{-1}$ | 1.12 |
| O.M (g kg$^{-1}$) | | | 7.2 |
| pH (Soil suspension) 1:2.5 | | | 8.36 |
| EC (dSm$^{-1}$, at 25 ºC) [Soil paste extract] | | | 4.27 |
| Soluble ions (mmolc L$^{-1}$) | Cations | $Ca^{++}$ | 8.94 |
| | | $Mg^{++}$ | 9.25 |
| | | $Na^{+}$ | 22.86 |
| | | $K^{+}$ | 1.67 |
| | Anions | $CO_3^{-}$ | --- |
| | | $HCO_3^{-}$ | 10.35 |
| | | $CL^{-}$ | 16.46 |
| | | $SO_4^{-}$ | 15.91 |
| Exchangeable cations (cmol kg$^{-1}$) | | $Na^{+}$ | 11.70 |
| | | $Ca^{++}$ | 10.39 |
| | | $Mg^{++}$ | 12.69 |
| | | $K^{+}$ | 4.41 |
| CEC (cmolc kg$^{-1}$) | | | 39.19 |
| ESP % | | | 29.85 |

**Experiment description**:

Five groups of 15 soil columns cylindrical polyvinyl chloride (PVC) tubes with a height of 45 cm and 15 cm inner diameter as shown in figure 2, it were used as the following treatments Table 2. Each column contained 3.5 kg soil, mixed well with gypsum requirement GR at a rate of 10.3 ton fed$^{-1}$ which were calculated to decrees the initial ESP from 29.8 to >15% in soil samples according to (FAO and IIASA, 2000). Water content was maintained at field capacity. Drained water samples were periodically taken by a suction pump every 30 days until the end of the period 150 days in order to study the state of dissolved salts and to estimate SAR, so that we can track and calculate the exchangeable sodium percentage ESP and to know the extent of the efficiency of agricultural gypsum as an amendment and its extent to be affected by irrigation water quality.

**Table 2. Details of defiant treatments**

| Treatment no | Irrigation water quality type (SAR) mmol c $L^{-1}$ |
|---|---|
| T1 | Control(distilled water) |
| T2 | S1 SAR<10 |
| T3 | S2 SAR >10 |
| T4 | S3 SAR>18 |
| T5 | S4 SAR >26 |

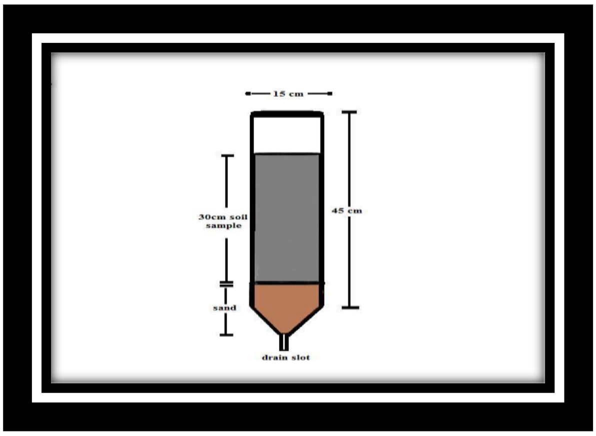


**Fig. 2. Experiment columns**

**2- Soil analysis:**

Soil samples were analyzed before and after carrying out the experiment, then some physical and chemical properties were undertaken according to the standard methods of (Page et. al., 1982), (Klute, 1986) and (Six et al., 2002). At the end of the experiment after the period of 150 days, soil samples were collected from each treatment and the dissolved ions were estimated. The exchanged ions were also estimated to calculate the exchangeable sodium percentage to compare the results to find out the extent to which the efficiency of agricultural gypsum is affected by the quality of the irrigation water.

- The sodium adsorption ratio (SAR) was estimated as an indicator of possible soil sodification using the Equation of USDA (1954):- $SAR = Na^{+} / \sqrt{[(Ca^{+2} + Mg^{+2} /2]}$

**Where:**

**$Na^{+}$ = Sodium concentration in the irrigation water in meq/l.**
**$Ca^{+2}$ = Calcium concentration in the irrigation water in meq/l.**
**$Mg^{+2}$ = Magnesium concentration in the irrigation water in meq/l.**

- Gypsum requirements were determined according to the methods described by U.S., salinity laboratory staff (FAO and IIASA, 2000) from the equation

$$GR = (ESP_i - ESP_F)/100 \times CEC \times 1.72$$

**Where:** **GR: gypsum requirement (ton.$fed^{-1}$), $ESP_i$: initial soil ESP, $ESP_f$: the required soil ESP and CEC: cation exchange capacity (cmolc $kg^{-1}$).**

**3- Statistical Analysis**:

The obtained data were subjected to a statistical analysis using the XLSTAT statistical package (Version 2018, Excel Add-ins soft SARL, New York, NY, USA). Analysis of variance was conducted as outlined by Steel and Torrie (1980). Duncan's Multiple Range Test was used to do mean comparisons Duncan, B. (1955).

## RESULTS AND DISCUSSION

Data in table 3 show the values obtained of EC and pH in the solutions collected by suction pump at regular intervals during the experiment periods (after 30, 60, 90, 120 until 150 day s respectively ) in order to tracking the condition of the soil after adding agricultural gypsum and the irrigation with water of varying qualities. By following up the results obtained, it becomes clear that in the control treatment, as the water is free of salts, this did not affect the efficiency of agricultural gypsum. The EC values were recorded after 30 days in control treatment (2.56 $dSm^{-1}$) as a result of the dissolution of the salts in the soil, including agricultural gypsum. The decrease in EC values for this treatment continued until the end of the total experiment period till reaching (1.65 $dSm^{-1}$). By comparing the control treatment with other treatments (different SAR degrees), it becomes clear that the higher degree of (SAR) followed by increasing in EC values in the drained water. It also increases in one treatment over time as a result of the accumulation of salts especially in treatments number 4 and 5 when the SAR values were higher than 18 and higher than 26, respectively. Also by following up the pH values during the experiment period for the different treatments, it was found that in the control and the treatments with SAR values less than 18, the values of pH decreased with time as a result of the interaction of agricultural gypsum, Sodium solubility and washing from the profile.

While in the treatments with SAR values higher than 18 (treatments 4 and 5), the pH values increased with time as a result of low agricultural gypsum efficiency affected by the high sodium concentrations in the irrigation water.

**Table 3. EC and pH values in suctioned extract at regular times during the experiment.**

| Treatments | After 30 day | | after 60 day | | After90day | | After120day | | After150day | |
|---|---|---|---|---|---|---|---|---|---|---|
| | EC $dS.m^{-1}$ | pH | EC $dS.m^{-1}$ | pH | EC $dS.m^{-1}$ | pH | EC $dS.m^{-1}$ | pH | EC $dS.m^{-1}$ | pH |
| 1 | 2.56$^{h}$ | 7.94$^{ef}$ | 2.32$^{hi}$ | 7.69$^{ef}$ | 1.93$^{ij}$ | 7.66$^{f}$ | 1.90$^{f}$ | 7.64$^{f}$ | 1.65$^{j}$ | 7.65$^{f}$ |
| 2 | 4.41$^{g}$ | 8.12$^{def}$ | 4.32$^{g}$ | 8.13$^{def}$ | 4.29$^{g}$ | 8.06$^{ef}$ | 4.31$^{g}$ | 7.9$^{ef}$ | 4.46$^{g}$ | 7.7$^{ef}$ |
| 3 | 4.89$^{g}$ | 8.32$^{abcde}$ | 4.42$^{g}$ | 8.32$^{abcde}$ | 4.62$^{g}$ | 8.19$^{bcdef}$ | 4.45$^{g}$ | 8.24$^{bcdef}$ | 4.79$^{g}$ | 8.18$^{cdef}$ |
| 4 | 6.87$^{e}$ | 8.71$^{abc}$ | 5.94$^{f}$ | 8.77$^{abc}$ | 6.43$^{ef}$ | 8.69$^{abcd}$ | 6.87$^{e}$ | 8.75$^{abcd}$ | 7.62$^{d}$ | 8.82$^{ab}$ |
| 5 | 8.23$^{c}$ | 8.74$^{abc}$ | 8.92$^{b}$ | 8.77$^{abc}$ | 9.23$^{ab}$ | 8.78$^{abc}$ | 8.79$^{b}$ | 8.91$^{a}$ | 9.58$^{a}$ | 8.89$^{a}$ |

**Within each column, means with the same letter are not significantly different ($p \leq 0.05$)**

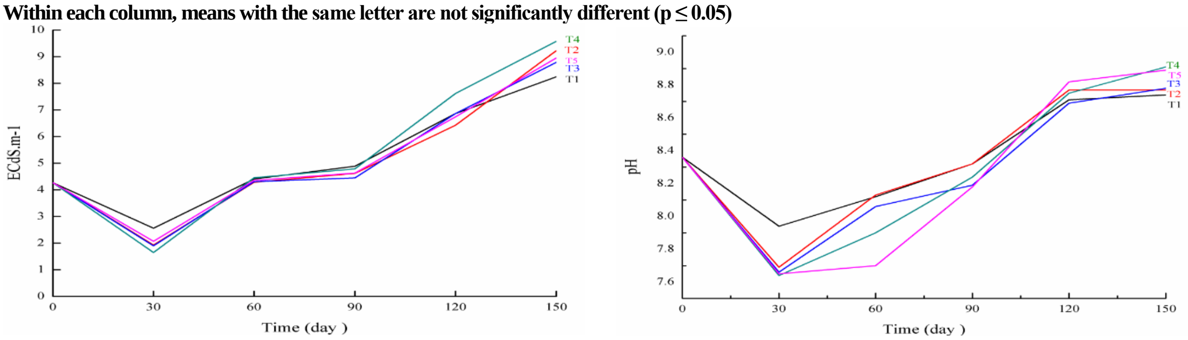


**Fig. 3. Soil EC and pH values during experiment periods**

From the previous results, it is clear that the increasing of irrigation water content of dissolved salts, especially sodium, led to a decrease in the efficiency of agricultural gypsum as a result of the accumulation of sodium and the inability of agricultural gypsum to displacement the exchangeable sodium from the soil profile.

**Table 4. Exchangeable cation, ESP % and CEC in the treated soils after 150 days.**

| Treatments | Exchangeable cations (Cmolc kg$^{-1}$) | | | | ESP | CEC |
|---|---|---|---|---|---|---|
| | $Na^+$ | $K^+$ | $Ca^{2+}$ | $Mg^{2+}$ | % | (Cmolc kg$^{-1}$) |
| **1** | 4.26 $^e$ | 2.83 $^a$ | 19.74 $^a$ | 13.01 $^b$ | 10.69 $^e$ | 39.85 $^a$ |
| **2** | 6.03 $^d$ | 2.52 $^{bc}$ | 16.93 $^b$ | 14.34 $^a$ | 15.15 $^d$ | 39.82 $^a$ |
| **3** | 6.62 $^c$ | 2.45 $^c$ | 17.57 $^b$ | 13.19 $^b$ | 16.62 $^c$ | 39.83 $^a$ |
| **4** | 8.42 $^b$ | 2.77 $^{ab}$ | 16.85 $^b$ | 11.64 $^c$ | 21.22 $^b$ | 39.68 $^b$ |
| **5** | 15.27 $^a$ | 1.79 $^d$ | 12.24 $^c$ | 10.36 $^d$ | 38.50 $^a$ | 39.66 $^b$ |
| ***Sig.*** | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* | *0.000* |
| ***LSD(5%)*** | *0.338* | *0.288* | *0.898* | *0.714* | *0.848* | *0.030* |
| ***C.V%*** | *2.29* | *6.40* | *2.96* | *3.14* | *2.28* | *4.16* |

**Within each column, means with the same letter are not significantly different ($p \leq 0.05$)**

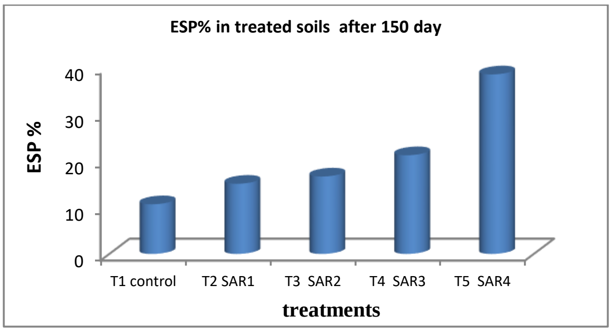


**Fig. 4. SEP% for treated soil after 150 day**

Data in Table4 and Fig 4 show the effect of soil treated with agricultural gypsum and irrigated with different water quality grades on the concentration of exchangeable cations and exchangeable sodium percentage ESP after 150 days. It is clear that the increase in the exchanged sodium was shown in the treatments with high values of SAR compared to the control treatment with distilled water (free of salts) where the exchanged sodium values were recorded as (4.26-6.01-6.63-8.42 and 15.27) Cmol$_c$ kg$^{-1}$ at SAR values (0-6-14-22-30) respectively, this in turn affects exchangeable sodium percentage (ESP) and it tends to raise the soil alkalinity in varying proportions. According to (Choudhary et al. 2011) and (Mohamed 2017). Deterioration of the chemical properties of the soil and the rise in the percent of (ESP) this is due to the use of low-quality water, especially in the long term. ( In the case of this research, the accumulation of sodium in the soil column led to a decrease of agricultural gypsum efficiency in variable proportions according to the concentration of sodium in the irrigation water).

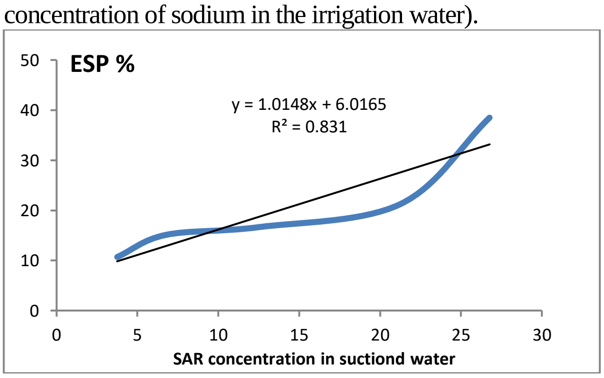


**Fig. 5. Linear relationship between ESP and SAR**

By studying the relationship between the SAR values in the water sample drained from the soil columns and the ESP measured in the laboratory after the end of the experiment period, it was found that, as shown in Figure (5), and according to (Zare et al. 2014) there is a good correlation between them and the correlation coefficient $R^2 = 0.831$ and the liner equation was as follows:

$$ESP=1.0148\ SAR+6.0165$$

This means that the higher the concentration of sodium (SAR) in the suctioned water from the soil columns, the higher the (ESP) values. This also means that the agricultural gypsum efficiency at the end of the period was not sufficient to reduce (ESP) to the required value (15%).This requires making a relationship between the sodium content of irrigation water (SAR) and the amount of gypsum requirement (GR)

## CONCLUSION

The results showed an increase in the values of pH, EC in treatments that contain high concentration of sodium used in irrigation water, which led to a decrease in the efficiency of agricultural gypsum through the soil column of experiment compared to the control, also results showed a liner relationship between SAR and ESP and it was found that the higher values of SAR be followed by an increase in ESP and the following liner equation was obtained:- ESP = 1.0148SAR + 6.0165 where R2 = 0.831 .it was also found that , by increasing in SAR values in irrigation water , the efficiency of agricultural gypsum decrease.

Therefore, this research recommends adjusting the amounts of agricultural gypsum added to the soil which irrigate with water have a high content of sodium in order not to lead to an accumulation of sodium in the root zone, according to the deduced liner equation.

## REFERENCES

Al-Busaidi, AS., and Cooksen, P. (2003). Salinity-pH relationships in calcareous soils. Agri Marine Sci 8: 41-46.

Al-Omran, A. M., Al-Harbi, A. R., Wahb-Allah, M. A., Mahmoud, N., and Al-Eter, A. (2010). Impact of irrigation water quality, irrigation systems, irrigation rates and soil amendments on tomato production in sandy calcareous soil.Turkish Journal of Agriculture and Forestry, 34 (1), 59–73

Amezketa, E. Aragues, R. and Gazol, R. ( 2005) Efficiency of Sulfuric acid, mined gypsum and two gypsum by-products in Soil crusting prevention and sodic soil reclamation. Agron. J., 97, 983-989.

Chaudhry, M.R. (2001). Gypsum efficiency in the amelioration of saline sodic/sodic soils. Int. J. Agric. Biol., 3(3), 276-280.

Chen, L., and Dick, W. A. (2011). Gypsum as an agricultural amendment: General use guidelines. Ohio State University Extension, Columbus. http://ohioline.osu.edu/b945/index.html (accessed 4 Jan. 2013.

Chintala, R., McDonald, L. M., and Bryan, W. B. (2010). Grouping soils by taxonomy order to improve lime recommendations. Commun. Soil Sci. Plant, 41, 1594-1603.

Choudhary, O. P., Ghuman, B. S., Bijay-Singh, Thuy, N., and Buresh, R. J. (2011). Effects of long-term use of sodic water irrigation, amendments and crop residues on soil properties and crop yields in rice-wheat cropping system in a calcareous soil. Field Crops Research, 121(3), 363–372.

Duncan, B. (1955). Multiple Range and Multiple F. test. Biometrics, 11, 1-42

Ezeaku, P.I.; Ene, J. and Shehu, J.A. (2015). Application of different reclamation methods on salt affected soils for crop production. Ame. J. Exp. Agric., 9 (2): 1-11.

FAO (2005) Integrated management for sustainable use of salt-affected soils. (Eds.: A. Mashali, D.L. Suarez, H. Nabhan, R. Rabindra) *Soils Bulletin*, Rome.

FAO and IIASA (2000). Diagnosis and improvement of saline and alkali sols, USDA Handbook No 60, U.S. Salinity Lab. Staff (1954), Washington

Fisher M. (2011). Amending soils with gypsum. Crops and soils magazine. American Society of Agronomy, Madison. pp. 4-9.

Hafez, E. M., Hassan, W. H. A. El, Gaafar, I. A., and Seleiman, M. F. (2015). Effect of Gypsum Application and Irrigation Intervals on Clay Saline-Sodic Soil Characterization, Rice Water Use Efficiency, Growth, and Yield. Journal of Agricultural Science, 7(12), 208.

Hamza, M.A and Anderson, W. K. (2003) Responses of soil properties and grain yields to deep ripping and gypsum application in a compacted loamy sand soil contrasted with a sandy clay loam soil in Western Australia. Australian Journal of Agricultural Research, 54, 273-282.

Horneck, D. A., Ellsworth, J. W., Hopkins, B. G., Sullivan, D. M., and Stevens, R. G. (2007). Managing Salt - affected Soils for Crop Production. November. A Pacific Northwest Extension publication Oregon State University . University of Idaho . Washington State University.

Khosla, B. K., Gupta, R. K., and Abrol, L. P. (1979). Salt leaching and the effect of gypsum application in a saline-sodic soil. Agric. Water Manag., 2, 193-202.

Klute, A. (1986). "Methods of Soil Analysis (part 1)". American society of Agronomy, Inc. Soc. Amer., Inc. Madison, Wisconsin, USA. 3rd edition.

Mohamed, N. N. (2017). Management of salt-affected soils in the Nile Delta. Handbook of Environmental Chemistry, 55, 265–295.

Moukhtar, M.M., El-Arquan, M.Y.S., El-Hadidy, E.M. and El-Shewikh, M.A.B. (2003). Amelioration of salt affected soils in north Dakhlia Governorate through application of tile drainage and subsoiling. J.Agric. Sci. Mansoura Univ., Special Issue, Sci. Symp. On problems of soils and waters in Dakhlia and Damietta Governorate. March 18.

Page. A.L.; Miller, R. H. and Keeney, D. R. (1982) "Methods of Soil Analysis". Part-2: Chemical and Microbiological properties (2Ed.ed). Amer. Soil Sci. Soc. Madison, Wisconsin, USA.

Qadir,M., Oster, J.D., Schubert, S., Noble, A.D., and Sahrawat, K.L. ( 2007). Phytoremediation of sodic and saline-sodic soils. Adv. Agron. 96, 197–226.

Sharma, B. R., and Minhas, P. S. (2005). Strategies for managing saline/alkali waters for sustainable agricultural production in South Asia. Agric. Water Manag., 78, 136-151.

Siosemarde, M., Kave, F., Pazira, E., Sedghi, H., and Ghaderi, S. J. (2010). Prediction of soil exchangeable sodium ratio based on soil sodium adsorption ratio. World Academy of Science, Engineering and Technology, 46 (September), 255–257.

Six, J.; Callewaeort, P.; Lenders, S.; DeGryze, S.; Morris, S. J.; Gregorich, E.G.; Paul, E. A. and Paustian, K. (2002) Measuring and understanding carbon storage in a forested soil by physical fractionation. Soil Sci. Soc. Am. J. (66): 1981–1987.

Steel, R.G.D., Torrie, J.H. (1980) Principles and Procedures ofStatistics. Mc. Graw-Hill Book Company, New York, USA.

USDA. (1954). Diagnosis and improvement of saline and alkali soils. U.S. Department of Agriculture (USDA). Handbook no. 60. U.S. Govt. Printing Office, Washington, USA.

Wong, V. N. L., Dalal, R. C., and Greene, R. S. B. (2009). Carbon dynamics of sodic and saline soil following gypsum and organic material additions: A laboratory incubation. Appl. Soil Ecol., 41, 29-40.

Zare, M., Ordookhani, K., Emadi, A., and Azarpanah, A. (2014). Relationship between soil exchangeable sodium percentage and soil sodium adsorption ratio in Marvdasht plain, Iran. International Journal of Advanced Biological and Biomedical Research, 2(12), 2934–2939.

## تأثير الري بمياه منخفضة الجودة علي كفاءة الجبس الزراعي في الأراضي القلوية

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**قسم الأراضي والمياه – كلية الزراعة – جامعة الأزهر بالقاهرة**

تم إجراء تجربة أعمدة بمزرعة قسم الأراضي والمياه بكلية الزراعة جامعة الأزهر بالقاهرة لدراسة تأثير الري بمياه منخفضة الجودة علي كفاءة الجبس الزراعي المضاف لتحسين خواص التربة القلوية ( أراضي مشروع ترعة السلام –غرب قناة السويس ) واستخدم في ذلك أربع درجات صلاحية للمياه حسب نسبة ادمصاص الصوديوم (SAR) بالأضافة الي معاملة الكنترول ( الري بماء مقطر). وكانت تسحب عينات مياه من أعمدة التربة بإنتظام كل 30 يوم لتتبع مدي التغير في بعض الخواص الكيميائية للتربة المعاملة بالجبس الزراعي ونوعيات مياه مختلفة . اظهرت النتائج انخفاض في قيم ال pH وال EC في كل من معاملة الكنترول والمعاملات ذات المحتوي المنخفض من الصوديوم بينما ارتفعت قيم الــ pH والــ EC في باقي المعاملات والتي تحتوي علي تركيزات عالية من الصوديوم مما أدي الي تقليل كفاءة الجبس الزراعي في التخلص من نسبة الصوديوم المتبادل من قطاع التربةوكنتيجة ايضا لتراكم الصوديوم في قطاع التربة. كما أوضحت نتائج تقدير الكاتيونات المتبادلة وايضا الــ ESP انه يوجد علاقة طردية بين ارتفاع تركيز الصوديوم في مياه الري وبين ال ESP في نهاية فترة التجربة وتم استنتاج هذه العلاقة رياضيا في صورة معادلة خطية كالأتي :- $ESP = 1.0148\ SAR + 6.0165$ حيث كان معامل الأرتباط بين المتغيرين $R^2 = 0.831$ . لذا يوصي هذا البحث بضرورة تعديل الأحتياجات الجبسية للتربة التي تروي بمياه منخفضة الصلاحية وخصوصا التي تحتوي علي تركيزات عالية من الصوديوم بحيث لا يحدث تراكم للصوديوم في منطقة نمو الجذور وكذلك حتي لا تقل كفاءة الجبس الزراعي المضاف لتحسين خواص الأراضي القلوية .