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[Jameel* 4(8): August, 2017] ISSN 2349-4506
Impact Factor: 2.785

Global Journal of Engineering Science and Research Management

EFFECT OF THE INTRECATION BETWWEN SALINE IRRIGATION WATER AND DRIP IRRIGATION SYSTEM (SUB-SURFACE) ON CHEMICAL AND PHYSICAL PROPERTIES OF THE SOIL IN ABU GHARIB DISTRICT

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DOI: 10.5281/zenodo.845659

KEYWORDS: Drip irrigation, electrical conductivity, Sodium Adsorption Ratio, Mean Weight Diameter, saturated hydraulic conductivity, and bulk density.

ABSTRACT

A field study was conducted in Soil Research Department (Ministry of Agriculture), located in Abu Ghraib district to study the effect of irrigation water salinity and drip irrigation system on soil properties according to using of drip irrigation system (under the surface) and through specific scenarios included the quality of water used (S): 1. Tap water (S_0): (0.6 - 0.7 ds/m), 2. Medium-salinity water (S_1): (2.6 – 3.0 ds/m), 3. High-salinity water (S_2): (4.9 – 5.1 ds/m), and 4. The alternating irrigation method (S_3): through using one irrigate of tap water followed by one irrigate of highly saline water. The results showed the increase of the chemical properties and the decrease of the physical properties of the soil when the irrigation by water salinity ($S_2, S_3,$ and S_1), also, the decrease of the chemical properties and increase of the physical properties of the soil when the irrigation by water salinity (S_0), addition to, the increase of the chemical properties in the depths (0-10, and 30-45cm) when using drip irrigation system (sub-surface) more than the depths (10-20, and 20-30 cm) with the decrease of the physical properties in the depth (0-15) when using drip irrigation system (sub-surface) more than the depth (15-30 cm).

INTRODUCTION

Iraq depends in providing its agricultural production on irrigated agriculture, where, considering the irrigation is the main pillars to increase agricultural production in Iraq. Irrigated agriculture was dependent on resources of good quality of irrigation water which was readily available, but with use increase of these resources for irrigation as a result to, climatic and human factors, and the rule of surface irrigation methods in agriculture, these reasons caused significant shortage in the amount of water of these resources and the remaining are low-quality waters (saline water). This saline water is containing quantities of dissolved salts, which affect directly, or indirectly on soil and production in case its accumulation in large quantities, where, it causes negative consequences, in term, deterioration of soil properties, decline the amount of agricultural production.

LITERATURE REVIEW

Salinity irrigation water used in the irrigation process effects multiple properties of the soil. The chemical properties of soil are most affected by saline irrigation water, where, it has observed [1] that irrigation water salinity caused significant increase in soil salinity (EC_s) of the (0-30), and (30-60) depths, as well, showed [2] in (2000) that, mixed and saline water caused significant increase in soil salinity (EC_s) (143.7, and 250%), respectively for (0-20) cm depth as compared with river water. As well, it was observed that the ionic composition of irrigation water can affect the quality of the ions prevailing in the soil solution depending on the concentration of these ions in the irrigation water. Such as, if increased calcium and magnesium ions concentrations with irrigation water reduce the amount of sodium that will be bound to soil particles, whereas, sodium ion is common in soils irrigated with water containing high concentration of sodium ion and this helped on increase Sodium Adsorption Ratio (SAR) as showed [3], where, observed [1] in (2000) that irrigation water salinity caused significant increase in (SAR) of the (0-30), and (30-60) depths, as well, showed [2] that, mixed and saline water caused significant increase in (SAR)(71.7, and 119.5%), respectively for (0-20)cm depth as compared with river water. Also, salinity irrigation water has negative effects on the physical properties of soil, where, cause the increase of sodium ion in the irrigation water to increase the percentage of exchangeable sodium in the soil, thus, the soil suffering from dispersion and swelling because of the relatively smaller size of sodium ion, its single electrical charge and hydration status. Sodium ion makes the bonds or bridges between adjacent soil particles very weak, and easily broken when they come in contact with water by the chemical and physical forces of water, particularly, when Ca^{2+}ion concentration in the soil solution decreases. The dispersion and swelling processes works on the release of individual soil particles from aggregates, and the movement with the water down the soil profile and deposition of the particles into soil pores, thus, it causes plugging of soil pores, reducing for each of porosity, hydraulic conductivity(K_{sat}), infiltration, and increasing for each of surface crusting, soil erosion in streams and waterlogging, in addition to, increasing the bulk density of the soil, (Frenkel et al. [4]), for all these reasons, [5] was observed that saline water only reduced the mean weight dimeter significantly by (42%) as compared with river water, as well, he noted that there was no significant difference in bulk density for (0-20) cm among treatments, also, it has observed through laboratory experiment was carried out by, [6], that, bulk density was increased linearly as the salinity level of irrigation water increased, while, hydraulic conductivity (K_s), and Mean weight diameter (MWD) values were decreased as the salinity of irrigation water increased.

There many of effective scientific ways and sound for using and management salinity irrigation water, these ways prevent the accumulation of salt in soil and it contribute to mitigate the negative effects of saline irrigation water on soil properties. Form these successful mothed, the alternating irrigation method through using low salinity water alternating with the high salinity water, where, it was found [6] when using drip irrigation system that all each of MWD, and saturated hydraulic conductivity decreased less when irrigation through alternate irrigation method compared with irrigation by saline water, also, he observed that, bulk density of soil increased by saline water more than alternate treatment.

MATERIALS AND METHODS

The Preparation of Field:

The chosen of land plot with area (26 m x 26 m) to conduct the field work, this land has been plowed by the mold board plow, then the soil is softened by disk harrows, then field is flooded with water for purpose of leaching soil of salts, and left for a period of two weeks, then the land is plowed, again. Main furrows excavated through the use of furrows machine. The land is dividing into four major sectors, the dimensions for each sector are (4 m x 26 m) with leaving a comma space between each two sectors (2 m) for the purpose of controlling the movement of water and salts between the sectors. The single sector is divided into four experimental units shaped plots (replicates), the total number of experimental units is 16 plots, the area of each experimental unit is 16 m^2 (4 m x 4 m) with a comma space between each unit and another (2 m) to prevent or reduce the movement of water and salts from one unit to another. The experimental unit (plot) consists of five furrows and six terraces. The distance between each two furrows (0.75 m) and the length, width, and depth of each furrow are (4, 0.5, and 0.2 m), respectively.

Experimental Scenarios:

For the purpose of simulation, the effect of irrigation water salinity and drip irrigation system used on soil properties, the following scenarios were used for implementation of experiment and which included four levels of salinity, as following: **A**- Tap water (S_0) (0.6 - 0.7 ds/m), **B-** Moderately saline water (S_1) (2.6 – 3.0 ds/m), **C**- Highly saline water (S_2) (4.9 – 5.1 ds/m), and **D**- Alternating irrigation (S_3) through using one irrigate of municipal water followed by one irrigate of highly saline water. The total number of experimental units was 16 experimental units in four sectors, [(4 water levels) × (1 irrigation systems) × (4 replications)]. Table (1) illustrates experimental scenarios used in the experiment. To study the effect of each factor of the factors involved in the experiment individually or overlapping with each other, Variance analysis program (GenStat) was used in the statistical analysis of data of this experimental.

Irrigation Aspects:

A-Water Supply System: the water supplying system included the following parts:

1- Reservoirs to store water with network of pipes for equipping the water to these reservoirs from the main sources.

2- Pump operating on fuel petrol was used for payment water from the reservoirs to the field,

3- Disk Water Filter for removing the suspended sediments and the undesirable materials from water.

4- Fertilized tank was used for fertilizing the soil.

5- Main conveyor plastic pipe (main line) was used for receiving water from the reservoirs to the sub-pipes (sub main lines) in the experiment field.

B-Drip Irrigation System (Sub-Surface): it included the following parts:
1-Sub-Main Pipe was used for conveying water from main pipe to the lateral pipes.
2- Discharge Gauge (Flow Meter) was used to calculate the volumes of water used in irrigation.
3- Pressure Regulator (Manometer) was used to regulate the system pressure at the operating pressure required to obtain water discharges constant of emitters.
4- Drain Pipe was installed at the end of sub-main pipe for the disposal of the remaining water after each irrigation process, and to ensure that mixing does not occur with different salinity water which is irrigated in the subsequent irrigation.
5- Lateral Pipes were used to conveyance the water from sub-main pipe to the felid pipes.
6-The Field Pipes (Drip Lines) were used to irrigate the experimental units for the field with (4 m) length for each plot, the distance between the lines is (0.75 m). Each line, consists of 14 emitters, the distance between emitters is (25 cm). Drip pipes were buried at (10 cm) depth.

C. Evaluation of Drip Irrigation System:
After the installation of drip system, and before the implementation of the study, evaluation process for this system were conducted through the following criteria:
1- Emitters Discharges Measurement: It was found that the optimal discharge rate of emitters is (4.2 L/hr.) when the operating pressure is (1 bar).
2- Measuring Uniformity Coefficient of Water Distribution in the Field (U_c): It found that uniformity coefficient of emitters in field lines is (99.26 %) at an operating pressure of (1 bar).
3- The Proportion of Variation in the Emitters Discharge: it found that the proportion of variation in the discharge of field lines emitters for drip system is (3.28 %) at an operating pressure of (1 bar).

D. The Calculation of Water Requirements of the Crop:
The values for each of actual evapotranspiration when using furrow irrigation system (ET_a) and when using drip irrigation system ($ET_{crop\ localized}$), and gross irrigation requirement (IR_g) when agriculture of the maize crop as reference plant, it was calculated according to the following equations (1, 2, and 3), respectively, (Brouwer, and Heibloem [8]; Savva, and Frenken [9]).

$$ET_a = ET_o \times K_c \qquad (1)$$

Where: ET_a = Actual evapotranspiration of the crop (mm/day).
ET_o = Reference evapotranspiration (mm/day).
K_c =Crop coefficient.

$$ET_{crop\ localized} = ET_a \times K_r \qquad (2)$$

Where: $ET_{crop\ localized}$= Actual evapotranspiration of the crop when irrigation by drip irrigation system (mm/day).
ET_a = Actual evapotranspiration of the crop when irrigation by surface or sprinkler irrigation systems
(K_r) = Reduction coefficient.

$$IR_g = \frac{ET_a}{E_a} - (P_e + LR) \qquad (3)$$

Where: IR_g = Gross irrigation requirement (mm/day).
ET_a = Actual evapotranspiration of the crop (mm/day).
P_e= The effective rainfall (mm/day).
LR = Leaching requirement (mm/day).
E_a= Field application efficiency (irrigation efficiency) (%).

E. Irrigation Scheduling:

irrigation processes of the field are carrying out depending on attrition moisture basis for the root zone depth when the moisture depletion reaches 50% of available water (initial moisture) in this depth through the using of the gravimetric method and through follow-up development of roots depth of the plants, and based on three stages, it is (the beginning of agriculture, the vegetative growth stage, and the flowering stage until the end of the physiological maturity stage). The calculation of the added water depth to compensation moisture depletion from the field capacity was conducted through the use of the following equation, (Kovda, et al. [10]):

$$d = (\theta_{F.c} - \theta_{bi}) x\ D\ x\ A_w \qquad (4)$$

Where: d= The added water depth (mm).
$\theta_{F.c}$=The volumetric moisture content at field capacity.
θ_{bi}= The volumetric moisture content before the irrigation.
D = Soil depth required at the effective root system (cm).
A_w= The wetted area ratio (%).

As for the calculation of the irrigation time by drip irrigation system, it is depending on the added water depth to reach to field capacity and constant discharge of emitters and according to the following equation:

$$t = \frac{A\ x\ d}{Q_{drip}\ x\ n} \qquad (5)$$

Where: t = Irrigation time (hr.).
Q_{drip}= The discharge of emitters (drip lines)(L/hr).
A=The cultivated area (m^2).
d = Depth of the water added (mm).
n = Number of emitters on the field Lines.

Laboratory Work:

Laboratory work included the implementation of the following activities:

A. Water Samples:

Water samples were collected from the water sources used in the irrigation process in the field, where, the samples analyzed at three-time intervals are (before planting, after one month of the planting, and end of the agricultural season)). Table (1) shows the chemical characteristics of the water sources used in the irrigation process.

Table 1: The Chemical Characteristics of Irrigation Water

Well water (No.2)			Well water (No.1)			Municipal water			Water source	
Sampling intervals										
June	Apr	Mar	June	Apr	Mar	June	Apr	Mar	Chemical characteristics	
7.7	7.8	7.4	7.6	7.5	7.3	7.5	7.45	7.2	pH	
5.6	5.4	4.9	2.7	2.65	2.45	0.68	0.63	0.65	(EC_{iw}) (dS/m)	
16.6	15	15.6	5.5	5.2	5.2	5	4.7	4.3	Calcium (Ca^{+2})	Positive ions (mmol/L)
21.4	18.8	19.3	12.5	11.2	12.4	3.2	2.8	2.9	Magnesium (Mg^{+2})	
23.9	22.1	23.6	11.84	11.26	11.4	1.9	1.9	1.7	Sodium (Na^{+})	
28	29.1	28.4	14	14.2	16	5	5.2	4.6	Sulphates (SO_4^{2-})	N e

23.6	23.8	20.5	10	7.5	8	2.5	2.9	2.5	Chlorides (Cl^-)	
1	1.2	0.8	1	0.8	1	0.8	0.6	0.65	Carbonates (CO_3^{-2})	
3.3	3.7	4.1	2.2	2.4	2.1	1.2	1.5	1.3	Bicarbonate (HCO_3^-)	
7.45	8.5	7.63	5.5	5.6	5.6	2.8	3.1	3.3	Nitrates (NO_3^-)(ppm)	
5.48	5.37	5.65	3.94	3.93	3.84	0.93	0.98	0.89	SAR $(mmol/L)^{1/2}$	

B. Soil Samples:

Before agricultural, representative soil samples of the field (disturbed samples) were collected from four depths (0-10, 10-20, 20-30, and 30-45 cm) randomly from several locations distributed on the field. Soil samples was taking by using Auger, and dried aerobically, then grinded by a wooden hammer to pass through (2 mm diameter) sieve to determine soil case (chemically). Also, undisturbed and disturbed soil samples were taken from two depths (0-15, and 15-30) in the same locations of the points to determine the physical properties of the soil. Tables (2), and (3) shows the chemical and physical characteristics of the field soil, respectively before agricultural. For observation, the negative and positive impacts for each of saline irrigation water and drip irrigation system on soil properties during the agricultural season, the chemical and physical analysis of soil samples, it was conducted from same depths at the end of the agricultural season with a sampling for knowing the changes in the chemical properties, which included (salinity (EC_s), (SAR) at depths (0-10, 10-20, 20-30 and 30-45 cm) of soil, figures (3, 4, 5, 6, and 7) and the physical properties, which included (Mean Weight Diameter (MWD), saturated hydraulic conductivity (K_{sat}), total porosity (f), and bulk density (ρb)) at depths (0-15 and 15-30 cm) of soil.

Table (2): The chemical characteristics of the field soil before agricultural

30-45	20-30	10-20	0-10	Soil depths (cm) Chemical characteristics	
7.51	7.5	7.48	7.56	pH	
4.42	3.65	3.36	3.21	(EC_{se}) (dS/m)	
16.5	12.4	12.6	12.3	Calcium (Ca^{+2})	Positive ions (Cation) mmol/L
12.38	10.15	10.06	10.01	magnesium (Mg^{+2})	
11.45	10.75	10.25	10.2	Sodium (Na^+)	
8.2	8.8	7.9	6.7	Sulphates (SO_4^{2-})	Negative ions (anions) mmol/L
21.9	20.6	21.5	21.8	Chlorides (Cl^-)	
Nill	Nill	Nill	Nill	Carbonates (CO_3^{-2})	
2.5	2.3	2.2	1.9	Bicarbonate (HCO_3^-)	
3.01	3.20	3.04	3.05	SAR $(mmol/L)^{1/2}$	
23.13	22.2	20.3	20.13	cation exchange capacity (CEC) (Meq/100gm soil)	
1.71	1.96	1.94	2.13	Organic matter (OM)	(%)
0.29	0.15	0.12	0.11	Gypsum ($CaSO_4$)	
23.67	22	26.83	22.83	Lime ($CaCO_3$)	

Table (3): The physical characteristics of the field soil before agricultural.

30-45	20-30	10-20	0-10	Soil depths (cm) Physical characteristics	
7.6	8.0	10.0	7.6	Sand	Si ze dis
42.8	44.0	42.4	44.8	Silt	

49.6	48.0	47.6	47.6	Clay		
Slit clay loam	Slit clay loam	Slit clay loam	Slit clay loam	Texture		
66.45	61.75	62.25	65.24	0	Tensile moisture (bar)	Gravimetric moisture content (%)
24.77	24.24	25.31	25.46	0.33		
21.86	21.49	21.80	20.62	1		
18.73	18.68	17.22	17.40	5		
15.29	16.58	15.53	15.33	10		
13.55	13.73	13.16	13.04	15		
11.22	10.51	12.15	12.42	Available Water (AW)		
5.61	5.25	6.07	6.21	depletion (50 %) of AW		
15-30		0-15		Soil depths		
0.52		0.51		Mean Weight Diameter (MWD) (mm)		
3.57		3.82		Hydraulic Conductivity (K_{sat}) (cm/hr.)		
1.36		1.33		Bulk Density (ρb) (Mg/m^3)		
2.65		2.65		Particle density (Mg/m^3)		
0.486		0.498		Total Porosity (f)		

RESULTS AND DISCUSSION

In terms of the effect of using saline irrigation water on the chemical properties of the soil when irrigation by drip irrigation system (sub-surface). It was observed that, soil salinity (EC_S) and sodicity (SAR) at the depths (0-10, 10-20, and 20-30 cm), respectively, gradually decreased to the lowest possible values at the end of the agriculture season when the use of tap water (S_0) with a slight increase of EC_S at depth (30-45 cm) compared with the values before the agriculture (figure 1), and (figure 2). The reason for this is due to the use water a low salinity, which causes increases calcium ion ratios and decreases sodium ion ratios in soil because it contains a small percentage of sodium ion versus a high percentage of calcium ion, thereby, this causes the declination of SAR in the soil, in addition to improving the hydraulic properties of the soil and increasing the vertical movement of water and increasing leaching processes of salts from these depths, thus, the saline accumulation was somewhat lower compared with the values of soil before the agriculture.

At the depth (0-10 cm), it has been observed when the use of water ($S_1, S_2,$ and S_3) that there is a pronounced increase in EC_S with increasing water salinity, compared with EC_S when irrigation by water (S_0), (figure 1). As well, it has been observed that there is increase very sharp in SAR of soil, compared with SAR when irrigation by water (S_0), (figure 2). The reason for increases EC_S and SAR, it is due to the using of high salinity water, particularly, (S_2) when irrigation by the drip irrigation method, which is characterized by increases horizontal movement of water (radial movement) with the surface in all directions and decrease vertical movement with depth in field soil because of slow wetting pattern of the emitters, therefore, the efficiency of leaching the salts is low with this depth, in addition to, this depth more susceptible to evaporation than other depths because rising temperatures with the advent of summer, as well, the effect of the aggregates stability of soil and regularity of the capillary tubes that has helped to get movement adverse to soil moisture in the intervals between irrigations to carry salts of sub-surface depth to the this depth, for this reason, the salts are collected significantly in this depth, especially, sodium ion because the containment of irrigation water (S_2) high proportions of sodium ion compared with the calcium and magnesium ions, this helped to increased its concentration in this depth more than calcium ion and magnesium ion (figures 3, 4, and 5), thus the sodic index of soil (SAR) is rising.

At the depths (10-20, and 20-30 cm), respectively, and when using of the irrigation water ($S_1, S_2,$ and S_3), it was observed that EC_S and SAR in these depths were lower than the values in the depths (0-10, and 30-45cm), (figure 3), and (figure 4). The reason for this is due to the high effectively of drip irrigation system in the removal of salts from these depths to the depths beneath because the site of the drip pipes into the soil profile (sub-surface) and its proximity from these depths and the getaway of these depths from the evaporation surface with increase the vertical movement of irrigation water and the salts because the conditions of field soil (slit clay loam) which contain a high percentage of silt (besides clay) which contains larger pores compared with the small pores of clay structure, this has helped to increase the vertical movement of irrigation water with the salts which carry around

ISSN 2349-4506
Impact Factor: 2.785
Global Journal of Engineering Science and Research Management

at a greater rate with depth, addition to, noting that each of the irrigation water (S_1), which is characterized by medium value in terms of the salinity compared with the highly saline water (S_2)with its containment proportions magnesium ion was somewhat higher than proportions ion sodium, and alternately irrigation method (S_3) which is characterized by its ability on the reduction of salinity, in addition to the containment for each of tap water and high salinity water on high levels of calcium ion in case alternately irrigation (S_3), this caused an increase concentrations calcium and magnesium ions in soil compared with sodium ion and increase their impact in competing with sodium ion on exchange surface of soil particles, thereby, reducing the effect of the sodium ion and declining the values of sodic indicator (SAR) in these depths.

It was observed that the greatest values for each of the rates of electrical conductivity and SAR were at depth (30-45 cm) compared to the rest of the depths above, (figure 3), and (figure 4). The reason for that is due to the salinity at this depth was greater before the agricultural season compared to the rest depths, in addition to, leaching the salts accumulated at the second layer depths (10-20, and 20-30 cm) with irrigation water in larger quantities to the lower depths such as, (30-45, and 45-60 cm) of soil with observation that the sodicity rises greatly in this depth from soil, especially, when the usage of irrigation water (S_2) which contemning high proportions of sodium ion compared with the calcium and magnesium ions.

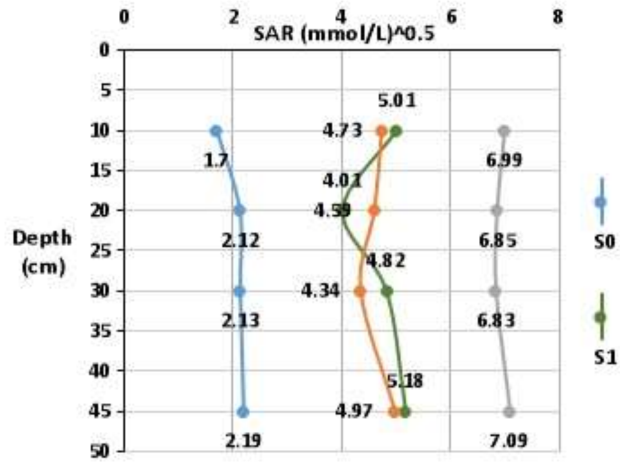

Figure 2: The means of (SAR) in the soil

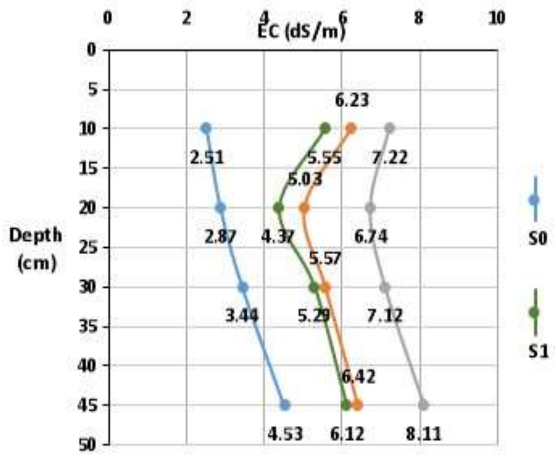

Figure 1: The means of (EC_S) in the soil

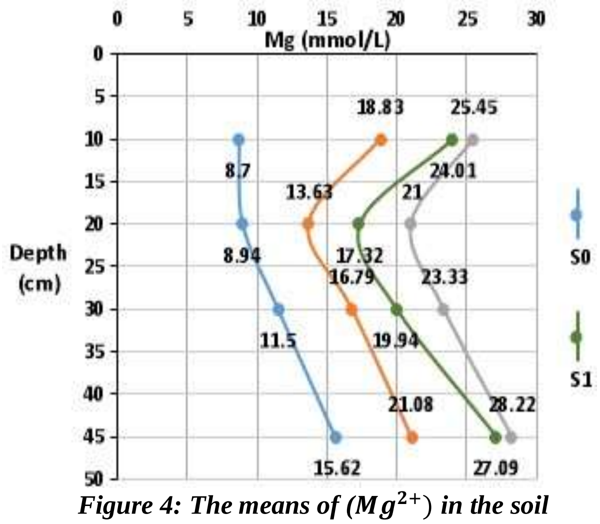

Figure 4: The means of (Mg^{2+}) in the soil

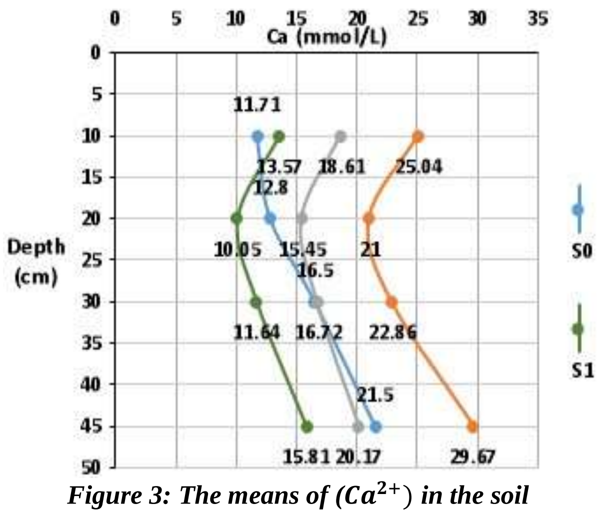

Figure 3: The means of (Ca^{2+}) in the soil

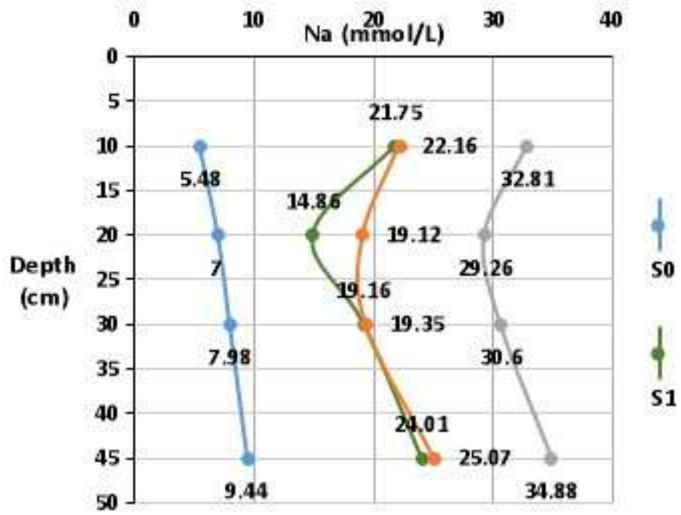

Figure 5: The means of (Na^+) in the soil

In terms of the effect of using saline irrigation water on the physical properties of the soil when irrigation by drip irrigation system (sub-surface), and by reviewing the linear equations and the strength of correlation between values of EC_s and SAR with the physical properties (R-squared value), it has observed increase or decrease of the physical properties as a result to increase or decrease of EC_s and SAR in the soil solution, figures (6, 7, 8, 9, 10, 11, 12, and 13). It has observed at the depths (0-15, and 15-30 cm), that the largest values of physical characteristics (MWD, porosity, and hydraulic conductivity) compared with the physical properties of the soil before planting were when using the tap water (S_0), which is characterized by low levels of salinity, in addition to, its containment on small concentration of sodium ion and high concentration of calcium ion, this helped on increases calcium ion ratios and decreases sodium ion ratio, thus, improving the hydraulic properties of the soil and increasing of the leaching operations of the salts accumulated including sodium ion, thereby, the declination of EC_s and SAR in the soil solution, with the declination of bulk density values.

At the depths (0-15, 15-30 cm), it has observed that the smallest values of physical characteristics (MWD, porosity, and hydraulic conductivity), compared with the physical properties when irrigation by (S_0) were when using the tap water (S_2), which contains high proportions of sodium ion compared with the calcium and magnesium ions, this helped to increased its concentration in soil, especially, with observation the decrease was larger in the depth (0-15 cm) because the low efficiency of leaching sodium ion in the drip irrigation system because slow wetting pattern of the emitters with increases horizontal movement of water (radial movement) in all directions with the surface and decrease vertical movement with depth in field soil (texture fine soil), in addition to, this depth more susceptible to evaporation than other depths with the occurrence of movement adverse to soil moisture in the intervals between irrigations to carry salts of sub-surface depth to this depth because the effect of the aggregates stability and regularity of the capillary tubes, for this reason, the salts are collected significantly in this depth including sodium ion, therefore, the deterioration of the soil aggregates stability is happening and the decline of physical characteristics values in this depth when using drip irrigation system was larger. This the deterioration through dispersion and decrease of porosity and hydraulic conductivity caused the increase of bulk density compared with the bulk density when irrigation by (S_0).

when using irrigation water (S_1) and the alternately irrigation method (S_3), it has observed that the values of (MWD, porosity, and hydraulic conductivity), respectively, were more than the values when irrigation by water (S_2) for the depths (0-15, and 15-30 cm) due to the irrigation water (S_1), it is characterized by medium value in terms of the amount of salinity, and it is contains high levels of magnesium ion, as well, the alternately irrigation method (S_3), it is characterized by the containment for each of tap water and high salinity water on high levels of calcium, this caused an increase concentrations for each of calcium and magnesium ions in soil compared sodium

RESEARCHERID
THOMSON REUTERS
[Jameel* 4(8): August, 2017] ISSN 2349-4506
Impact Factor: 2.785
Global Journal of Engineering Science and Research Management

ion and increase their impact in competing with sodium ion on exchange surface of soil particles, thereby, reducing the effect of the sodium ion and the deterioration of physical characteristics but a lesser extent compared with sodium ion when irrigation by water (S_2), addition to, that the site of the drip pipes into the soil profile (sub-surface) and its proximity from the depth (0-15 cm), it was contributed to the reduction of negative effects on the physical properties.

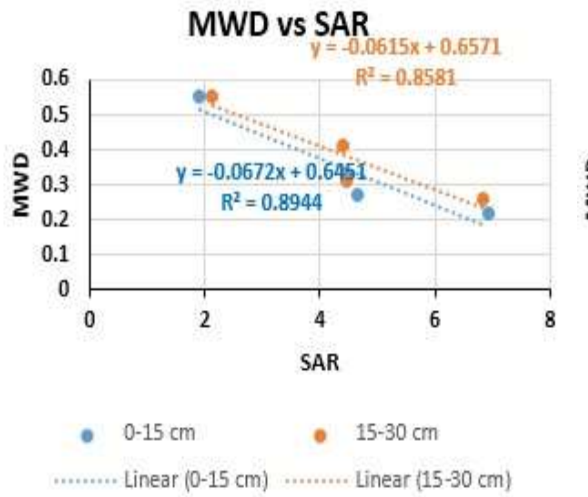

Figure 6: The means of MWD vs SAR

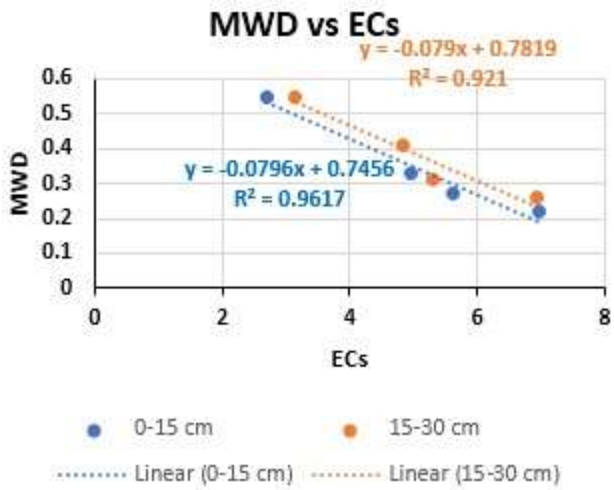

Figure 6: The means of MWD vs EC_S

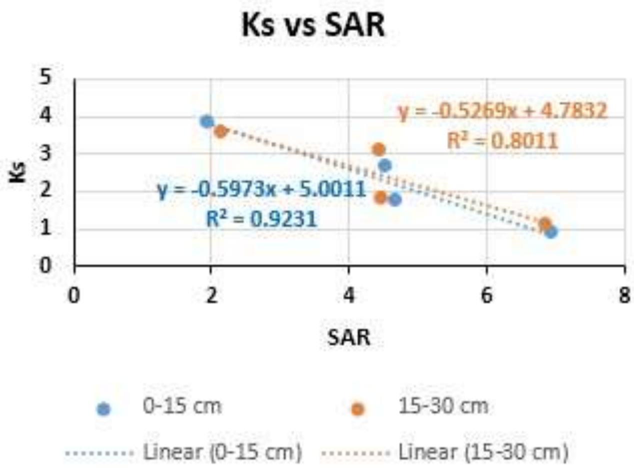

Figure 8: The means of K_{sat} vs SAR

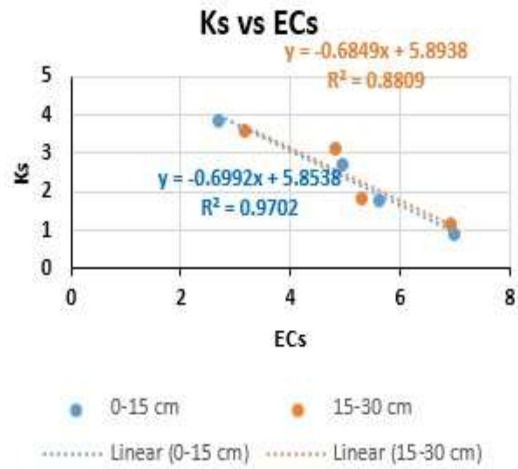

Figure 8: The means of K_{sat} vs EC_S

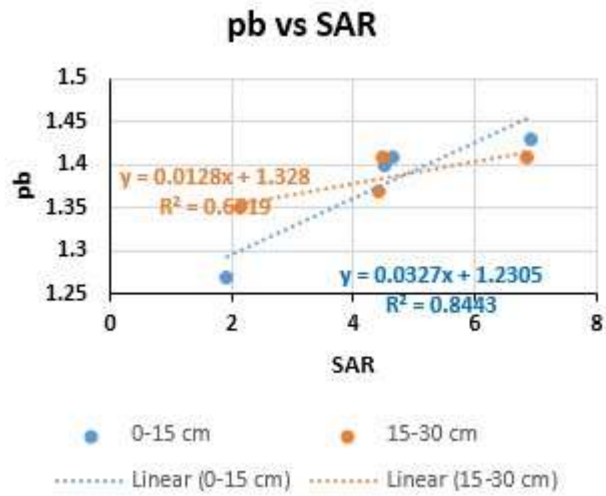

Figure 10: The means of ρb vs SAR

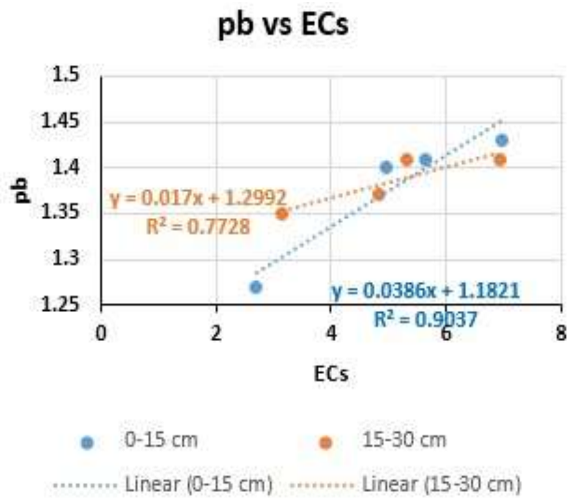

Figure 10: The means of ρb vs EC_S

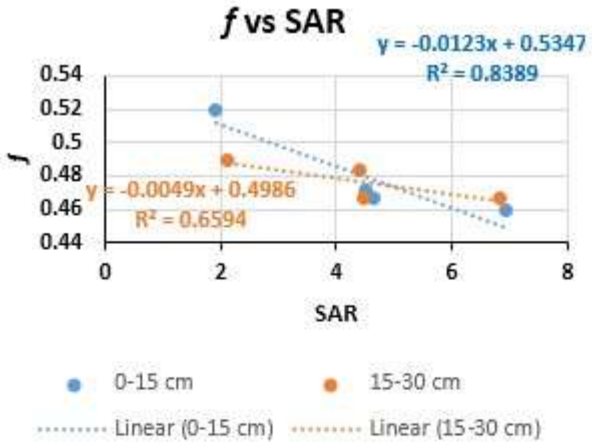

Figure 12: The means of f vs SAR

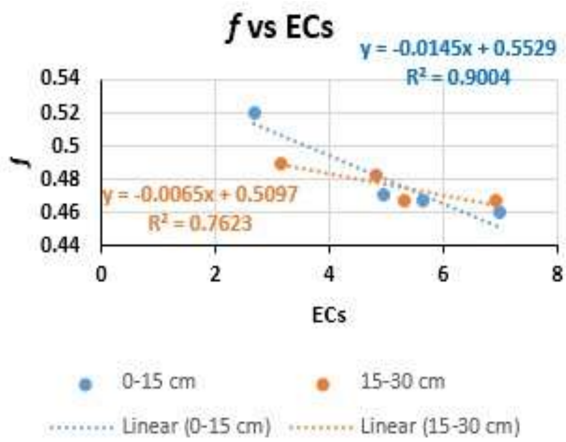

Figure 12: The means of f vs EC_S

CONCLUSION

1- The increase of EC_S and SAR of the soil when the irrigation by water salinity (S_2, S_3, and S_1), respectively.
2- The decrease of EC_S and SAR of the soil when the irrigation by water salinity (S_0).
3- The increase of EC_S and SAR in the depths (0-10, and 30-45cm) when using drip irrigation system (sub-surface) more than the depths (10-20, and 20-30 cm) when the irrigation by water salinity (S_2, S_3, and S_1).
4- The decrease of the physical properties of the soil when the irrigation by water salinity (S_2, S_3, and S_1), respectively.
5- The increase of the physical properties of the soil of the soil when the irrigation by water salinity (S_0).
6- The decrease of the physical properties in the depth (0-15) when using drip irrigation system (sub-surface) more than the depth (15-30 cm).

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