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Treatment of Water Drainage for Agriculture

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TREATMENTOFWATERDRAINAGEFORAGRICULTURE

Treatment of Water Drainage for Agriculture

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I. Introduction

Both irrigation water quality and proper irrigation management are critical to successful crop production. The quality of the irrigation water may affect both crop yields and soil physical conditions, even if all other conditions and cultural practices are favorable/optimal. In addition, different crops require different irrigation water qualities. Therefore, testing the irrigation water prior to selecting the site and the crops to be grown is critical. The quality of some water sources may change significantly with time or during certain periods (such as in dry/rainy seasons), so it is recommended to have more than one sample taken, in different time periods. The parameters which determine the irrigation water quality are divided to three categories: chemical, physical and biological. In this review, the chemical properties of the irrigation water are discussed. The chemical characteristics of irrigation water refer to the content of salts in the water as well as to parameters derived from the composition of salts in the water; parameters such as EC/TDS (Electrical Conductivity/ Total Dissolved Solids), SAR (Sodium Adsorption Ratio) alkalinity and hardness. The primary natural source of salts in irrigation water is mineral weathering of rocks and minerals. Other secondary sources include atmospheric deposition of oceanic salts (salts in rain water), saline water from rising groundwater and the intrusion of sea water into groundwater aquifers. Fertilizer chemicals, which leach to water sources, may also affect the irrigation water quality.

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The main problem related to irrigation water quality is the water salinity. Water salinity refers to the total amount of salts dissolved in the water but it does not indicate which salts are present in High level of salts in the irrigation water reduces water availability to the crop (because of osmotic pressure) and causes yield reduction. Above a certain threshold, reduction in crop yield is proportional to the increase in salinity level. Different crops vary in their tolerance to salinity and therefore have different thresholds and yield reduction rates. *Mohsen Seilsepour and Majid Rashidi (2008):* Studied Modeling of Soil Sodium Adsorption Ratio Based On Soil Electrical Conductivity The statistical results indicated that in order to predict soil SAR based on soil EC, the linear regression model SAR = 1.91 + 0.68 EC with R2 = 0.69 can be recommended,. *Mohsen Seilsepour et. al (2009)* Studied Prediction of Soil Exchangeable Sodium Percentage Based on Soil Sodium Adsorption Ratio The statistical results of the study indicated that in order to predict soil ESP based on soil SAR the linear regression model ESP = 1.95 + 1.03 SAR with R2 = 0.92 can be recommended. *Cannon et al (2004):* studied Measured and Estimated Sodium-Adsorption Ratios for Tongue River and its Tributaries, Montana and Wyoming The Tongue River drains an area of about 5,400 square miles and flows northward from its headwaters in the Bighorn National Forest of northeastern Wyoming to join the Yellowstone River at Miles City, Montana. Water from the Tongue River and its tributaries is extensively used for irrigation in both Wyoming and Montana, and show resulting in a high sodium-adsorption ratio (SAR). Disposal of ground water with high sodium concentrations into the Tongue River has the potential to increase salinity and SAR of water in the river, and potentially reduce the quality of water for irrigation purpose. *Yaohu Kang et.al (2010) :* studies the effects of drip irrigation with saline water on waxy maize and the Results indicated was the irrigation water with salinity <10.9dS/m did not affect the emergence of waxy maize. As salinity of irrigation water increased, seedling biomass decreased, and the plant height, fresh and dry weight of waxy maize in the thinning time decreased by 2% for every 1dS/m increase in salinity of irrigated water. The decreasing rate of the fresh ear yield for every 1 dS/m increase in salinity of irrigation water was about 0.4–3.3% Irrigation water use efficiency (IWUE) increased with the increase in salinity of irrigation water when salinity was <10.9dS/m. *Jamal et, al (2007):* Studied Irrigation Water Quality Evaluation With Special Reference to Wasit Governorate the

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classifications followed were the USSL and FAO systems, and then water suitability for irrigation was evaluated accordingly. The results showed that, all water samples fell within the water class (C3 – S1) according to USSL system. Whereas, in FAO system, the samples fell within the class (increase in salinity hazard) for the salinity hazard; within (no hazard, increase in permeability hazard) for soil permeability based on Eciw and Adj. SAR indicators; within (no hazard and increasing toxicity hazard) for toxicity based on (Na^{+}+Cl^{-}) concentrations; and within (increasing hazard) class for miscellaneous effects of irrigation water based on bicarbonate as showed the high content of (Ca^{+2}+Mg^{+2}) comparatively with Na^{+} ions decrease the hazard of residual bicarbonate (RSC) effects, and hence reduce soil ESP values.

II. Characterizing Salinity

There are two common water quality assessments that characterize the salinity of irrigation water. The salinity of irrigation water is sometimes reported as the total salt concentration or total dissolved solids (TDS). The units of TDS are usually expressed in milligrams of salt per liter (mg/L) of water. This term is still used by commercial analytical laboratories and represents the total number of milligrams of salt that would remain after 1liter of water is evaporated to dryness. TDS is also often reported as parts per million (ppm) and is the same numerically as mg/L. The higher the TDS, the higher the salinity of the water The other measurement that is documented in water quality reports from com mercial labs is specific conductance, also called electrical conductivity (EC). EC is a much more useful measurement than TDS because it can be made instantaneously and easily by irrigators or farm managers in the field. Salts that are dissolved in water conduct electricity, and, therefore, the salt content in the water is directly related to the EC. The EC can be reported based on the irrigation water source (ECw) or on the saturated soil extract (ECe). Units of EC reported by labs are usually in millimhos per centimeter (mmhos/cm) or decisiemens per meter (dS/m). One mmho/cm=1 dS/m. EC is also reported in micrommhos per centimeter (μmhos/cm) (1μmho=1/1000).

Often conversions between ECw and TDS are made, but caution is advised because conversion factors depend both on the salinity level and composition of the water *(Stephen R. Grattan2002).* For example

TDS (mg/L) = 640 x ECw (dS/m) when ECw < 5 dS/m

TDS (mg/L) = 800 x ECw (dS/m) when ECw > 5 dS/m

Sulfate salts do not conduct electricity in the same way as other types of salts Therefore, if water contains large quantities of sulfate salts, the conversion factors are invalid and must be adjusted upward.

III. Salinity Effects on Crops

The primary objective of irrigation is to provide a crop with adequate and timely amounts of water, thus avoiding yield loss caused by extended periods of water stress during stages of crop growth that are sensitive to water shortages. However, during repeated irrigations, the salts in the irrigation water can accumulate in the soil, reducing water available to the crop and hastening the onset of a water shortage. Understanding how this occurs will help suggest ways to counter the effect and reduce the probability of a loss in yield.

The plant extracts water from the soil by exerting an absorptive force greater than that which holds the water to the soil. If the plant cannot make sufficient internal adjustment and exert enough force, it is not able to extract sufficient water and will suffer water stress. This happens when the soil becomes too dry. Salt in the soil-water increases the force the plant must exert to extract water and this additional force is referred to as the osmotic effect or osmotic potential. For example, if two otherwise identical soils are at the same water content but one is salt-free and the other is salty, the plant can extract and use more water from the salt-free soil than from the salty soil. The reasons are not easily explained. Salts have an affinity for water. If the water contains salt, more energy per unit of water must be expended by the plant to absorb relatively salt-free water from a relatively salty soil-water solution *(Ayers and Westcot 1994).*

IV. Irrigation Water Quality Criteria

Soil scientists use the following categories to describe irrigation water effects on crop production and soil quality:

- Salinity hazard - total soluble salt content
- Sodium hazard - relative proportion of sodium to calcium and magnesium ions
- pH - acid or basic
- Alkalinity - carbonate and bicarbonate
- Specific ions: chloride, sulfate, boron, and nitrate

a) pH and Alkalinity

The acidity or basicity of irrigation water is expressed as pH (< 7.0 acidic; > 7.0 basic). The normal pH range for irrigation water is from 6.5 to 8.4.. High pH's above 8.5 are often caused by high bicarbonate (HCO_3-) and carbonate (CO_3^{2}-) concentrations, known as alkalinity. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution. As described in the sodium hazard section, this alkaline water could intensify the impact of high SAR water on sodic soil conditions. Excessive bicarbonate concentrates can also be problematic for drip or micro-spray irrigation systems when calcite or scale build up causes reduced flow rates through orifices or emitters. In these situations, correction by injecting sulfuric or other acidic materials into the system may be required. *(Bauder.et.al 2012).*

b) Sodium Hazard

Although plant growth is primarily limited by the salinity (EC_w) level of the irrigation water, the application of water with a sodium imbalance can further reduce yield under certain soil texture conditions. Reductions in water infiltration can occur when irrigation water contains high sodium relative to the calcium and magnesium contents. This condition, termed "sodicity," results from excessive soil accumulation of sodium. Sodic water is not the same as saline water. Sodicity causes swelling and dispersion of soil clays, surface crusting and pore plugging. This degraded soil structure condition in turn obstructs infiltration and may increase runoff. Sodicity causes a decrease in the downward movement of water into and through the soil, and actively growing plants roots may not get adequate water, despite pooling of water on the soil surface after irrigation.

The most common measure to assess sodicity in water and soil is called the Sodium Adsorption Ratio (SAR). *Sodium adsorption ratio (SAR):* is a measure of the suitability of water for use in agricultural irrigation, as determined by the concentrations of solids dissolved in the water. It is also a measure of the *sodicity* of soil, The SAR defines sodicity in terms of the relative concentration of sodium (Na) compared to the sum of calcium (Ca) and magnesium (Mg) ions in a sample *(Bauder.et.al 2012).*

The SAR assesses the potential for infiltration problems due to a sodium imbalance in irrigation water. The SAR is mathematically written below by equation 1, where Na, Ca and Mg are the concentrations of these ions in milliequivalents per liter (meq/L). Concentrations of these ions in water samples are typically provided in milligrams per liter (mg/L). To convert Na, Ca, and Mg from mg/L to meq/L, you should divide the concentration by 22.9, 20, and 12.15 respectively. Table (1)and (2) show limitation for SAR and EC depend for USSL and FAO and figure (1) show the determine SAR from {Na ,Ca ,Mg.}. (عصام خضير وجماعته)

$$SAR = \frac{Na^{+}{}_{meq/L}}{\sqrt{\frac{(Ca^{++}{}_{meq/L}) + (Mg^{++}{}_{meq/L})}{2}}} \quad (1)$$

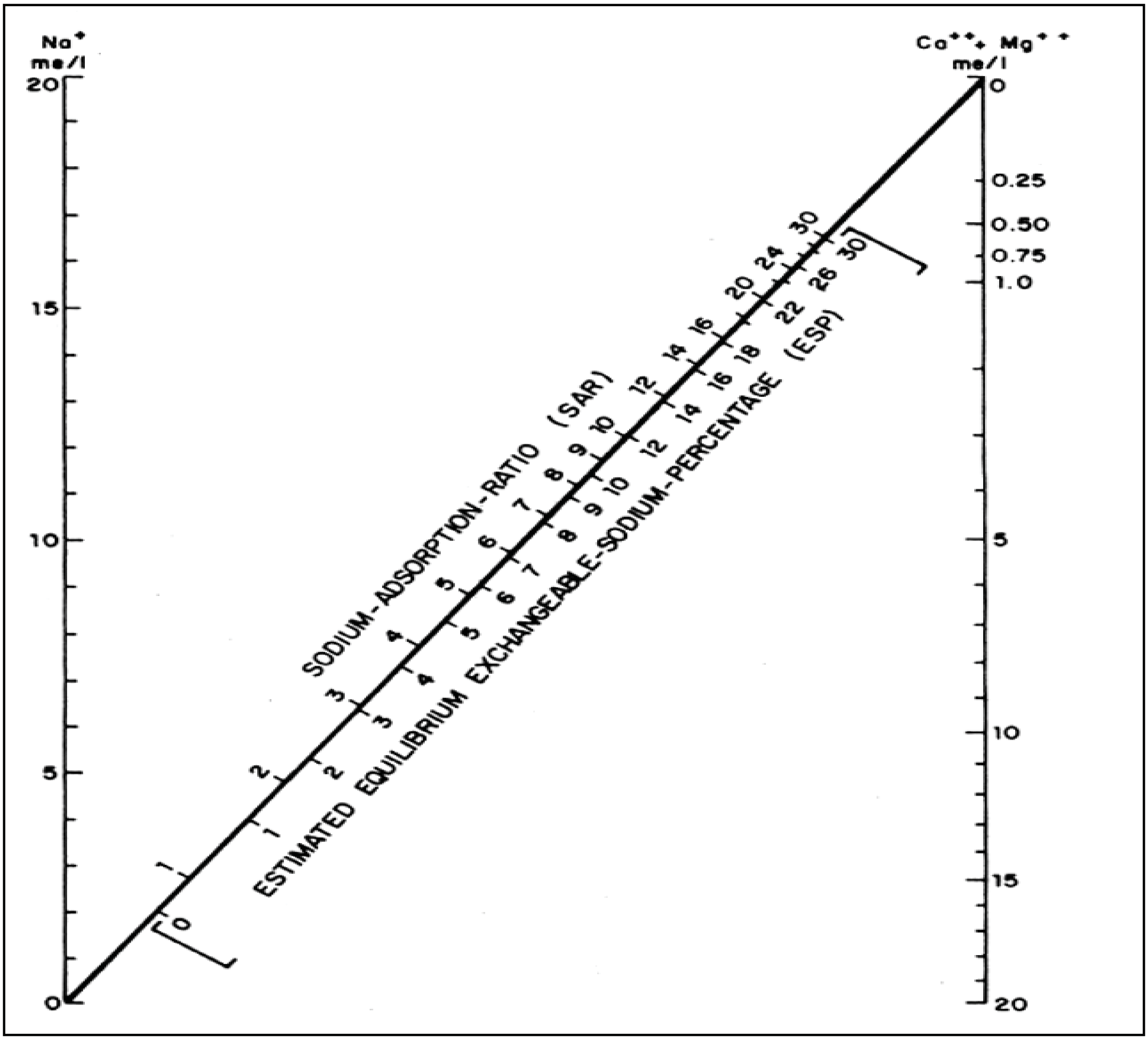

Figure 1 : Show the determining the SAR value of irrigation water

Table 1 : Show the Limit for Electrical Conductivity (EC)

Table (1) show the limit for electrical conductivity (EC)			Table (1) show the limit for electrical conductivity (EC)		
Class	Range (ds/m)	Notes	Class	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Low	0.25≤	C_1	Excellent	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Meduim	0.25-0.75	C_2	Good	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
High	0.75-2.25	C_3	Unsuitable	Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)
Very high	2.25≥	C_4		Table (1) show the limit for electrical conductivity (EC)	Table (1) show the limit for electrical conductivity (EC)

Table 2 : Show the Limit for Sodium Adsorption Ratio (SAR)

USSL (Richard) 1954			FAO Ayers and Westcot 1994		
Class	Range (ds/m)	Notes	Class	Range (ds/m)	Notes
Low	<10	S_1	Low	<3	
Meduim	18-10	S_2	Meduim	3-9	
High	18-26	S_3	High	9>	
Very high	>26	S_4			

V. Experimental Work

In this study, bring samples of water drainage and river water taken from the region Dujaili located in Wasit Governorate shown in figure 1, was taking samples during the month of December after it was mixing water drainage with river water at different ratios to get water containing salts proportions few For example, has the mixing process (90% of the river water +10% of the water drainage), as well as mixing (80% of the river water +20% of the water drainage) and also has the mixing process versa where the mixing (90% of the water drainage +10%river water), as well as mixing (80% of the water drainage +20% of the water of the river) as shown in table No. 3. the mixing process was in closed containers and was the tests in the laboratory of the College of Agriculture / University of Wasit. and has the test process for these samples by device flame photometer and devices PH and EC as shown in the figure 2 ,3 ,4 have been conducted I analyzes laboratory for these samples has been tested ions (Na, Ca, Mg) calcium and magnesium were estimated in a manner correction and sodium were appreciated your Flame Photometer, estimated electrical conductivity (EC) and the degree of interaction for sample of water using EC-meter and PH-meter then was calculated value sodium adsorption ratio (SAR) by equation 1.

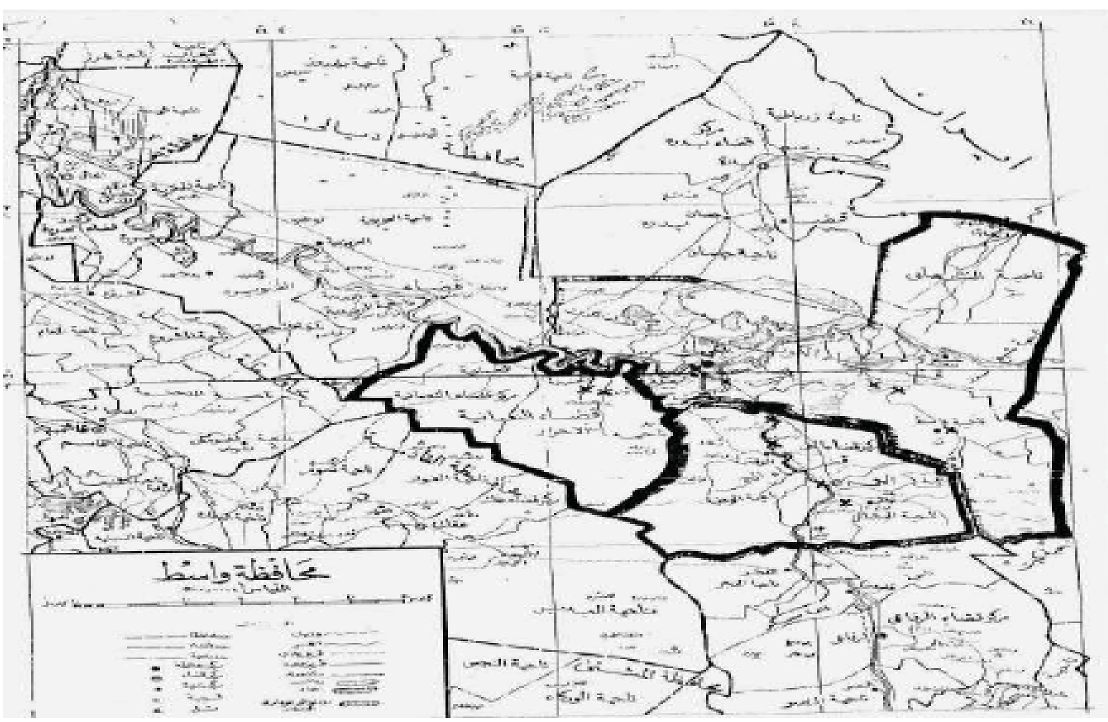

Figure 4 : EC Meter

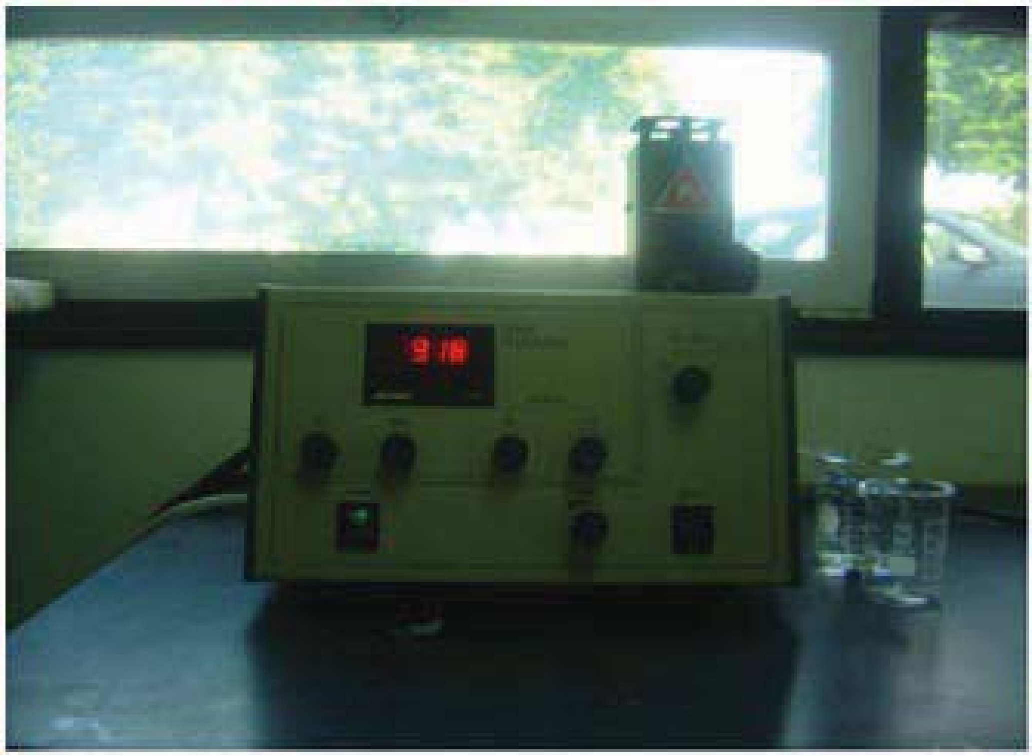

Figure 2 : Device Flame Photometer

Figure 3 : PH Meter

Figure 4 : EC Meter

VI. Results and Discussion

The study results showed that the samples water of percentage (10% drainage + 90% River), (20% drainage + 80% River) located within product (s_1) while water of percentage (30% drainage + 70% River), (40% drainage + 60% River), (80% drainage + 20% River), (70% drainage + 30% River), (60% drainage + 40% River) located within product (s_2) The water of percentage (50% drainage +50% River), (90% drainage + 10% River) located within class (s_3) this is according to the system USSL and FAO. Sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) incident within class (medium). Other ratios located within the third category (high) these category for SAR as for the electrical conductivity sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) located within the class (C_3) according USSL system, other percentages and located within the class (C_4) according USSL system either by the FAO system it sample water of percentage (10% drainage + 90% River), (20% drainage + 80% River) 30% drainage + 70% River), (40% drainage + 60% River) located within class good other percentage within third class the result tests for sample of water shown in table 3. Figure (5) show percentage of water drainage and EC. Figure (6) show percentage of water drainage and SAR.

Table 3 : Show the Result Tests for Sample of Water for Different Ratios

No.of sample	Water of river	Water of drainage	Na(meq/L)	Ca+mg(meq/L)	SAR	EC(mmhos/cm)	PH
1	90%	10%	20.07	13	7.87	1.80	7.83
2	80%	20%	28.2	20	8.92	2.10	7.72
3	70%	30%	35.63	17	12.2	2.50	7.4
4	60%	40%	41.46	15	15.13	3.00	7.48
5	50%	50%	44.17	11	18.8	5.50	7.51
6	10%	90%	63	24	18.15	18	7.54
7	20%	80%	57.65	23	17	17.6	7.72
8	30%	70%	52.47	18	17.49	15.6	7.74
9	40%	60%	49.23	17	16.86	14.16	7.68
10	50%	50%	44.17	11	18.8	5.50	7.51
11		Only drainage	69.43	12	28.33	19	7.64
12	Only river		4.96	10	2.21	1.19	7.88

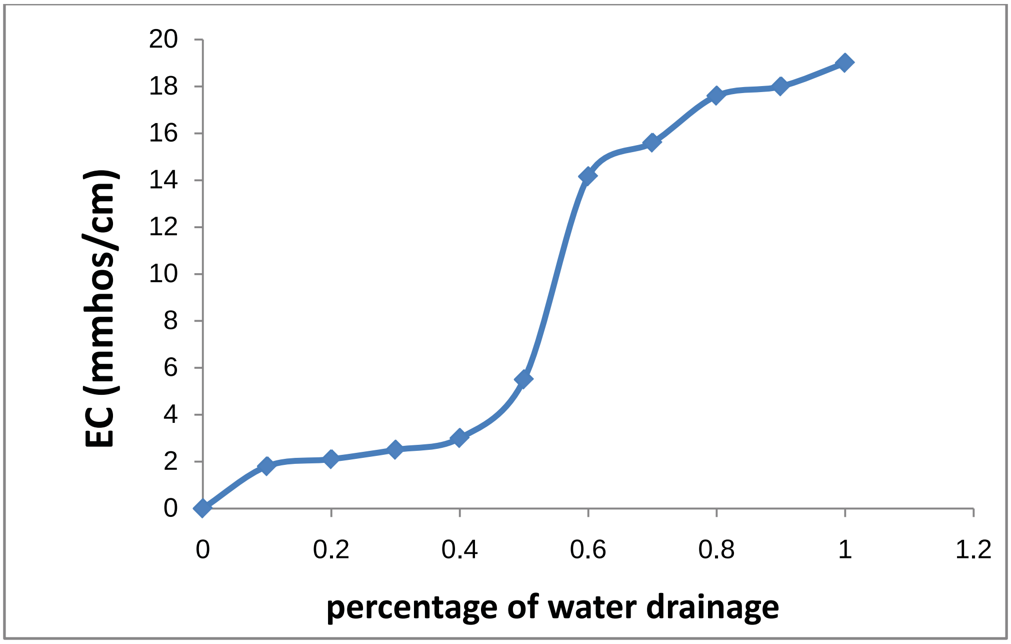

Figure 1 : show percentage of water drainage and EC

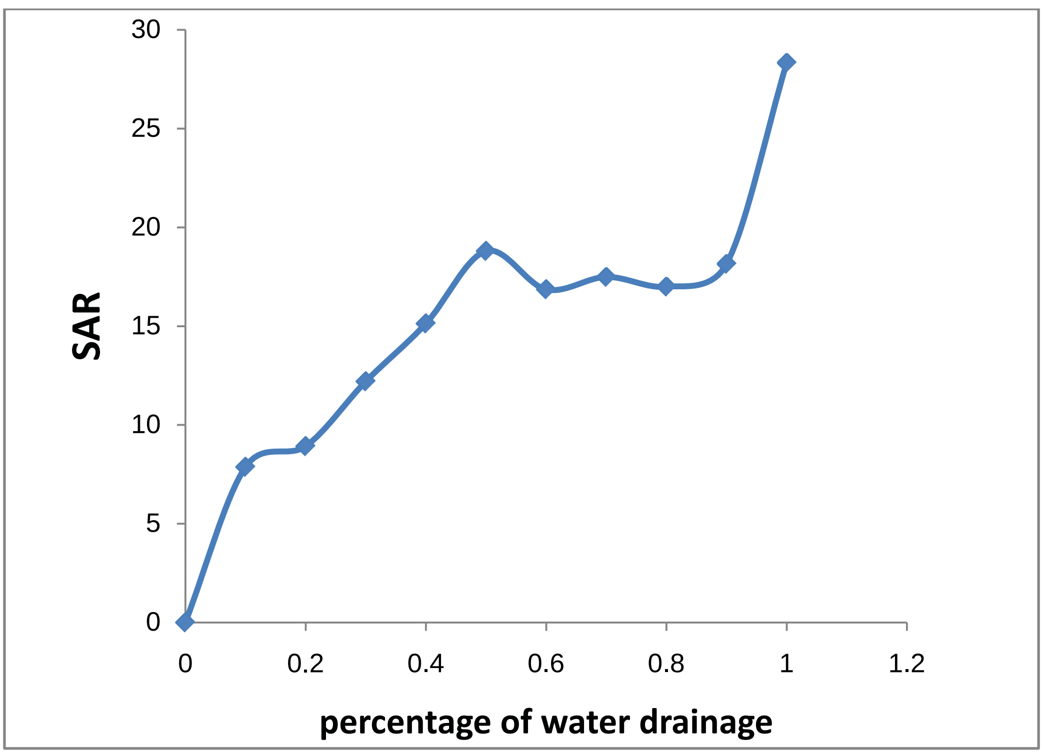

Figure 2 : show percentage of water drainage and SAR

VII. Conclusions and Recommendations

- The increased electrical conductivity lead to increased salt concentration in the water.
- The interaction pH values ranging between (7.40-7.88).
- Results were compared with laboratory salinity U.S (USSL). and Food Agriculture Organization of the United Nations (FAO) and found that the ratio favorite mixing process is (10%drainage +90% River) and (20 %drainage +80% River) located within ((S1-C3) according to the classification laboratory salinity U.S. While according to the

(FAO) the sodium adsorption ratio incident within class (medium) and the electrical conductivity sample located within class good.

- ❖ That determine the validity of water for irrigation and agriculture to not depend only on a laboratory tests for irrigation water, but must study other factors affecting determine the validity of water for irrigation and agriculture, including soil (determine characteristics of physical and chemical), type of crop grown and the bear saline, and climatic conditions include temperature, amount of precipitation rainfall, wind speed, the speed of evaporation, etc.) and management irrigation and drainage in terms of the availability of networks and appropriate irrigation techniques and good and effective drainage networks.

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