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Review of Reclamation of salinity affected soils by leaching and their effect on soil properties and plant growth

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ABSTRACT

The irrigated soils in dry and semi-arid areas suffer from the problem of salt accumulation because of not using sufficient leaching water to remove the salts added with the irrigation water. Soil salinity contributes to a decrease in the growth and productivity of plants grown in those conditions, as well as affecting the physical, chemical and hydraulic properties of the soil. The reclamation process is a radical solution to the problem of salinization, and one of the most important basic ingredients for the success of the process of reclamation of saline soils is to determine the optimal amount of leaching water or what is called (leaching Norm). Hence, the leaching process and the net movement of the leaching water are required to remove the salts to prevent them from concentrating in the root zone to the appropriate level for the plants' tolerance to ensure that it does not affect their growth and productivity. The concept of leaching a soil from salts and improving its physical and chemical properties depends on several factors, including the method of leaching, salinity, the amount of water added during the leaching process and the time period for leaching, as well as the properties of the soil and other factors. The salts present in the surface layer and their transfer with the movement of water to the depths and from there to the places of puncture, they also indicated that the increase in the leaching periods with low salinity of leaching water in the intermittent leaching method showed greater efficiency in using less quantities of water, in addition to that the increase in the leaching periods may increase From the speed of leaching salts from the soil, they also indicated that increasing the amount of water and leaching periods may contribute to reducing the salinity of the studied soil, especially in unsaturated soil conditions.

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INTRODUCTION
1- Characteristics of salinity affected soils:

The irrigated soils in the dry and semi-arid regions of the world suffer from the problem of salt accumulation because of not using sufficient leaching water to remove the salts added with the irrigation water. Also, wrong irrigation practices and poor salinity and quantity of irrigation water, as well as the lack of an effective drainage system contributes to increasing the salinity of the soil (Kitamura *et al*.; 2006). Salinity in soils is divided into primary and secondary, salinity depending on the sources from which it was formed in the soil, as primary salinity is formed as a result of weathering of primary minerals or the parent material, while secondary salinity is formed as a result of the wrong use of soil and irrigation practices that lead to the rise of high salinity ground water and its contribution to the process of salinization (Aslam & Prathapar, 2006). Soil salinity is represented by the presence of high concentrations of positive and negative ions such as sodium, calcium, magnesium, chloride, sulfate and bicarbonate, but the most effective of them are the sodium and chloride ions because of their toxic effect on plants and the effect of sodium on some physical and chemical properties of soil (Yadav *et al*.; 2007). The problem of soil salinity is one of

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the most important problems facing agriculture, as the high levels of salt in the soil leads, for example, to a high percentage of exchanged sodium, which leads to the dispersal of soil aggregates and the spread of its particles, which results in the lack of movement of water and air and the formation of a hard crust on the surface of the soil leads to obstructing seed growth, seedling death and reducing the amount of crop production (Al-Fadli *et al*.; 2007), and the accumulation of salts inside the soil and their accumulation in excessive quantities is a reason for the high osmotic pressure of the soil infiltrate, which leads to limiting the ability of plants to absorb water and nutrients, and thus impeding and weak growth (USDA,1998).

2- **Sources of salts:**

The type of source material (Parent material) and the availability of suitable climate conditions is one of the main sources for the formation of salts and thus the salinization of agricultural soils, also salts can be added through fertilizers or other soil conditioners, and when the ground water is highly saline and close to the surface of the earth, salts can accumulate in Soil through the process of evaporation, as saline soil is usually formed in arid climatic areas, and in coastal areas that involve seawater intrusion and irrigation with saline water (Anonymous, 1987). In irrigated soils, the salts dissolved in the irrigation water may increase the salinity of the soil, which leads to a high concentration of salts due to water absorption by plants and evaporation, which leads to the accumulation of salts in the root area, and the concentration of salts in irrigated soils is proportional to the volume of water removed by these processes (Bresler *et al*.; 1982)). Many salinity affected soils are formed as a result of water intrusion, and in general salt seeps are formed when excess water either from rainfall or irrigation enters the feeding area (the area of land that is a source of water for seewage) and leaches the salts down until they meet an impermeable layer. Loaded with salts lose the ability to move downward for a longer period, they move horizontally through the impermeable layer and eventually return to the low surface (collection area) upon evaporation, which gives the opportunity for salt accumulation, and salt seeps are characterized by the accumulation of salts in low places and lack of plant growth and the presence of water pools and slow Infiltration of water in the soil, and agricultural practices can affect changing the movement of water and transforming pasture areas into cultivated soils with the introduction of different agricultural cycles, where periods of downtime and lack of plants or leaving the land fallow allow the deposition of salts in the soil pot, which leads to salt water intrusio (Hoffman 2010). There are also other factors such as heavy rainfall, poor surface drainage, snow accumulation and sandy soil texture that allows draining more additional water, which can increase the formation of salt seeps (McCauley; 2005). Also, Rajabzadeh *et al*. (2009) indicated that the main causes of soil salinity are irrigation water salinity, increased evaporation, inadequate leaching, improper irrigation method and ineffective drainage. The salinity balance in the root zone is affected by chemical reactions that mostly involve soluble salts, the amount of salt leached out from the root zone of crops may be less than that added with irrigation water over time because salts are deposited in the root zone from the added irrigation water, which reduces the probabilities of salt balance (Hoffman 2010). The salinization process can also occur when saline groundwater moves upward from the shallow groundwater source in the crop root zone, and lowering the water level through subsurface dredging reduces capillary rise from groundwater, And most of the salt ions in seawater and in fresh water sources (but in smaller quantities) are chloride, sodium, magnesium, sulfate, calcium, potassium, bicarbonate and bromine. When they undergo cross-conjugation, these ions can collect with the predominance of evaporation conditions to form salt deposits such as $NaCl$, $CaCl_2$, $MgCl_2$, $CaSO_4$, $CaCO_3$. and KCl (El-Ghazlane & Mathiot, 2017). Salinity affects about 400 hectares of soils globally and about 80% of them are affected by primary salinization with the remaining 20% affected by secondary salinization due to human activities, such as agriculture, mining activities, as well as oil and gas extraction (Amini *et al*.; 2016).

3- **The effect of salinity on plant growth:**

Levitt, 1980 saied that the effect of salinity on plant growth is done in several ways:

1- Direct effects of salinity:

a-   These direct effects are specific toxic effects of salt, and this is caused by the effect of salts on the outer plasma membrane or in the cytoplasm after salt enters the plant cell's protoplast, where it affects many processes of plant growth and development and imbalances occur in the nature of the processes Different physiological factors such as photosynthesis and metabolism of proteins and nucleic acids, or the effect may be indirect, such as water relations (David & Nilsen, 2000).

b- The harmful effect of salts is not due to the changes caused by the salt itself, but to the presence of high concentrations of it that lead to secondary changes that are responsible for causing the damage, and these include:

1)   The osmotic effect: This effect occurs as a result of an increase in the concentration of salts in the soil solution or the growth medium, as it reduces the value of the total effort and then the plant is exposed to a secondary osmotic stress called physiological drought, and this leads to a decrease in the inflated pressure of the plant cells. Hence, it inhibits growth (Steven & Heap, 2001). The most common response of plants to growth is to show the effect of salinity, or the so-called salt stress, which may cause stunted crop growth, as soil salinity increases, especially in the root zone and thus on plants, where they spend more energy trying to obtain "pure" water and make chemical and biological changes necessary, and thus leave the least energy for plant growth processes (Corwin *et al.*, 2007), and generally the growth of crops is more related to the total concentration of salts in the soil rather than the concentration of specific ions present in the soil, although it should be noted that the higher concentration of ion Specific can cause toxic complications in plants, as Hoffman (2010) mentioned that the lack of production caused by osmotic stress can be exacerbated before the appearance of signs of deficiency on the leaves, and over time salts can accumulate in the woody plant tissues, which means the symptoms of salt stress that do not It can be seen for several years.

2) The effect caused by a lack of nutrients: This effect is due to high concentrations of salts, especially sodium chloride, as they work to inhibit the absorption of other elements necessary for plant growth and development and thus lead to an imbalance in the ionic balance, which affects plant growth.

2- The indirect effect of salinity:
     represented in the effect of salt on the physical and chemical properties of the soil, as high concentrations of sodium ion in the soil lead to a large exchange with binary positive ions, and then cause the dispersal of organic and inorganic particles in the soil pores, which reduces the Soil permeability and aeration increases surface runoff, this phenomenon can act on the plant growth environment and thus affect plant growth (Fay & Shi; 2012).

4-   Reclamation of salinity affected soils:
The process of reclamation of soil affected by salinity depends on many factors related to soil geomorphology and characteristics, climatic, crop cultivation and crop rotation, as well as other factors. Chemical and physical methods or the use of tolerant plants to reclaim salinity affected soils (Tintner *et al*., 2016). The International Rice Research Institute (IRRI, 2006; Irshad *et al*., 2008) stated that the available options for treating salinity-related problems are the following:

 A - Engineering reclamation: It includes the processes through which the plant growth environment is changed and made natural and suitable for plant growth by removing poor soil characteristics and adding good soil in its place, which requires resources and economic costs that may be exorbitant and costly for farmers (Qadir *et al*.; 2007).

 B - Bioreclamation: is the selection of the crop or the change of genetic engineering to be able to live in salt-affected soils, and the ability of plants to withstand salt stress to a certain level is of high importance for optimal resource management and this is the reason for the development of crops that have been adapted to a high salt tolerance that suits salt stress environments. (Bekheet *et al*.; 2006).

C - Hybrid reclamation: It includes both environmental modification and biological modification, which is high in productivity and less costly in terms of resources, which makes it a valuable orientation. Soil scientists have used many reclamation and management methods to reduce the risk

of salinity and problems of soil and untapped water, and reclamation operations will be easier with crops. High tolerant to salinity and more profitable from an economic point of view (IRRI, 2006).

Iraq began reclamation of saline lands since the forties of the last century in limited sites (Al-Zubaidi, 1992), then, an intensive program was carried out in the early seventies, including the development and revival of old irrigation projects, as well as the integrated soil reclamation for new projects, and the total areas covered by the land reclamation program amounted to about 3 million dunams completed until 1981 (Arar, 1982), and the establishment of drainage networks may be feasible to reduce the level of ground water and the movement of salts to the lower layers, but the obstacles to the complete success of this technique are its high cost Most of the farmers need large quantities of water, water salinity, low soil permeability, lack of drainage, and the ability of some salts to disperse soil particles (Irshad *et al*., 2008). As the leaching process needs to know and calculate the amount of leaching water needed (leaching norm), and there are many methods for this, including what Bresler *et al*. (1982) mentioned about the USSL (1954) salinity laboratory that calculates the quantities of leaching water (leaching norm) according to a general rule that derives its information from what is known as experience, as adding one foot (30 cm)) from the water leads to the removal of approximately 80% of the salts present in one foot of the soil, including the leaching curves, the most prominent of which are the curves reached by Dieleman (1963) in Iraq. Through these curves, it is possible to estimate the depth of the leaching water required to reduce the salinity rate to the required level, as for the other methods for calculating the standardized leaching, they are to derive empirical or quasi-experimental mathematical equations. Khoshgoftarmanesh *et al*. (2003) found in an experiment conducted in the city of Qom in Iran on clay soil using five methods to add leaching water (conventional irrigation, two additional leached before planting, one additional leached before planting, one leached after three days of planting and two additional leachs after three and nine days of planting Agriculture) The use of two leachings before planting the barley crop led to a decrease in the electrical conductivity rate, ECe, from 67.1 dSm^{-1} before planting to 7.1 dSm^{-1} after planting.

One of the most important steps of land reclamation is conducting field and laboratory studies to diagnose soil condition problems in terms of its chemical, physical and hydraulic characteristics, as the chemical characteristics include diagnosing the type of salts originally present in the soil. The solubility of positive ions (Ca^{++}, Mg^{++}, Na^+, K^+) and negative ions (SO_4^{--}, HCO_3^-, CO_3^{--}, Cl^-, NO_3^-), and the soils are divided in terms of their salinity into non-saline soils, saline soils, soda salt soils and sodic soils (Richards; 1954), and according to this classification, the salinity-affected soils in central and southern Iraq fall within the saline and saline sodic soils. In an experiment by Jiaxia *et al*. (2017) To reclaim saline-affected alluvial mixture soil in China using a drip irrigation system and using five depths of leaching water (320, 200, 120, 80 and 50 mm) at a rate of 10 mm for each irrigation and depending on the soil metric effort measured in meter (-5 and - 10, -15, -20 and -25 kPa) It was found that the use of a leaching water depth of 80 mm with a metric voltage higher than -20 kPa for a period of two months of leaching, contributed to reducing the salinity of the studied soil (10.3 dSm^{-1}) to less than 4 dSm^{-1} .The soil salinity increased with increasing soil depth to 8.4 dSm^{-1} at depth of 50-60 cm, and the amount of water used was reduced by 150-610 mm in the first three years of reclamation. In a laboratory experiment using soil columns set up in Iran by Javadi *et al*. (2019) using three levels of saline for leaching water (0.6, 3 and 6 dSm^{-1}), two leaching administrations and three leaching periods (8, 45 and 100 days), as the two leaching administrations included: 1- Intermittent when 30% of the capacity is exhausted 2- Field irrigation daily with the addition of 15% leaching requirements, and a heavy leaching was applied to the soil columns after 16, 56 and 114 days. The results showed that the leaching management and the leaching duration were more effective in leaching the soil, while the quality of the leaching water had a slight effect. And the efficiency of leachng with daily irrigation treatment is higher than intermittent leaching. In daily irrigation, soil salinity was controlled up to the average salinity of water (3 dSm^{-1}) and the greatest effect was recorded in reducing soil salinity and reducing drainage water compared to intermittent leaching, as well as increased leaching. The percentage of sodium adsorption in the soil by the intermittent leaching method compared to the

daily irrigation, and the physical and chemical properties of the soil in the daily irrigation treatment are more appropriate than the intermittent leaching treatment, and the leaching capacity under daily irrigation is higher than the intermittent leaching, as the continuous drying and moistening of the soil caused crusting The surface, as the study showed that the distribution of pain The plate becomes homogeneous after heavy leaching because the salinity level in the soil surface is greater than from the depth, where more salts were removed from the surface of the soil, which was deposited in the lower depths of the soil, and the amount of salinity after leaching was the same in both leaching administrations, and the highest salinity was recorded in the treatment of salt level 6 dSm^{-1} after 100 days from leaching at the beginning of the leaching period (4.03 dSm^{-1}), as the high salinity of the leaching water increased the salinity of the soil, and the increase in the leaching period and approaching the end of the leaching period caused an increase in salinity at the end of the period due to the high accumulation of salt, where the salinity was much higher than It was at the beginning of the period (Hoffman 2010).

5- Methods of leaching soil:

The process of leaching soil is easy and uncomplicated, as quantities of water are added to leached away the excess salts in the soil, and then immersed in water for a certain period of time, so that the stage of draining the water into the cesspools (Al-Ani, 1984). There are many factors that can determine the applied leaching method, such as changes in irrigation water salinity, soil initial moisture content, method of water addition, rainfall rate, ionization of mineral compounds and the effect of soil texture on leaching efficiency. Many laboratory and field studies related to salt leaching have been addressed. From soil the effect of flow velocity, initial moisture content and chemical and physical properties in the process of leaching salts from soil (Nielson and Bigger, 1962; Aylemore and Guirk, 1959; Krupp *et al*., 1972). Dias et al. (2001) found that the volume of water required to reclaim and leached the soil can be calculated as a function of the initial soil salinity, the final level of salinity required, the type and depth of the soil to be reclaimed, the method of water addition and the concentration of salts in the leaching water, and despite the publication of many studies using mathematical models to simulate the reclamation of saline soil, The amount of water used in leaching and reclaiming these soils is generally calculated using empirical relations. Kahlon *et al*., 2013 showed that soil leaching depends on soil building factors, water drop rate, soil depth, initial salinity concentration and the type of salts present, and that the effect of soil texture determines the amount of different irrigation water quantities during leaching of soda saline soils, and that leaching had a positive effect on The amount of salts leached out in those soils and that the largest amount of salts removed was recorded in the sandy-clay mixed texture compared to the sandy mixed texture and alluvial clay, and the clay soil texture can retain more water and dissolved materials within its aggregates compared to the sandy texture soil (Xu *et al*.,2015). There are Two traditional leaching methods are continuous and intermittent leaching. Continuous leaching is achieved by continuous immersion of water on the surface soil. In intermittent leaching, leaching water is added in the presence of a separator (rest) that allows redistribution of salts in the total pores (Ghafoor *et al*. 2004). According to El -Ghazlane & Mathiot (2017) the basic leaching techniques are superficial, intermittent, continuous, and partial leaching, as described below:

A- Surface leaching: The main variables for using the surface leaching method are the presence of shoulders and basins, where large quantities of leaching water are used and at low salinity levels near the edge of the shoulder, and the leaching water is drained superficially at the end of the shoulder of the basin, and in this method the largest amount is added From the leaching water compared to other leaching methods, where the leaching is done from the accumulation of salt by the horizontal flow of water and irrigation in the presence of a natural or artificial active drainage system (Corwin *et al*., 2007).

B- Intermittent leaching: where salts tend to accumulate below the seedbed due to the movement of salts down the leaching area, and the use of surface and intermittent leaching methods depends on the length of the field or basin, the rate of adding irrigation water, soil characteristics,

land slope, duration of leaching application and weather conditions, which are the factors that Affect the salinity of the root zone (Chu;2016).

C- Continuous leaching: It is the leaching methods that immerse the entire surface of the soil, which is carried out in soils where salinity increases with the depth of the soil below the root zone of crops, provided that the leaching occurs in a balanced or moderate manner, and the application of leaching is uniform and when the accumulation of salts is in the surface area of soil and when groundwater is not a limiting factor for leaching (Crown;2007).

D- Partial leaching systems (drip irrigation system): where water is added near or below the drippers or along the line of the drip system, and it has the advantage of having a high leaching advantage near the drippers, and it is also used when the groundwater is close to the surface and high salinity, The salinity of the root zone near the dots can be maintained by repeated additions and with the least amount of water added compared to other leaching methods, and the roots of plants tend to grow in the leached and wet area close to the water source, and this phenomenon also allows the management of salinity successfully in water containing a salt content Relatively high for use in irrigating crops without affecting the yield. In an experiment conducted by Kamel & Bakry (2009) with the aim of determining the most effective leaching methods in removing soluble salts from salinity-affected soils using continuous and intermittent leaching methods on heavy clay soils selected from the Tina Plain in Egypt, as the leaching process lasted for 21 months, Where the results showed that the two studied methods are effective for removing salts with the superiority of intermittent leaching due to the improvement of the physical properties of the soil such as the stability of the aggregates, the distribution of pore size and the leaching rate, and more than 30% of the net water used was saved compared to the water used by the continuous leaching method, where the leaching showed a correlation coefficient There was a significant difference between salt removal and water leaching for both leaching methods, which amounted to 0.9385 and 0.9075 for both the intermittent and continuous leaching method sequentially, as the study showed that more than 50% of the salts were removed from the surface layer after 3 months of leaching in both leaching methods and that the efficiency of continuous leaching was better. With a little more than that of intermittent leaching up to 6 months, while after 6 months the trend of leaching by intermittent leaching was better and it was attributed to the formation of cracks through wetting and drying during the leaching cycles, which Contributed to encouraging the movement of water downward, but after 21 months of the leaching process, the electrical conductivity of the soil for both leaching methods coincided, as the percentages of salts removed from the second and third layers (10-20 and 20-30 cm) are less than the surface layer (0-10 cm) at the beginning of the leaching due to the movement of salt from top to bottom. At the end of the leaching period, the salt was removed by the two methods, but the intermittent leaching was slightly better, and the curves indicated that in the case of continuous leaching, the average water conductivity rate of the soil was 0.11 cm hour^{-1} (0.0264 m day^{-1}), while the value increased in intermittent leaching to 0.32 cm hour^{-1} (0.0768 m day^{-1}), which indicates that intermittent leaching increases the soil filtration capacity to 2.5 times the value compared to the continuous leaching method . Unsaturated conditions allow sufficient time for the exchanged materials to dissolve at the exchange surfaces, so that they can then be removed by the stream of water passing through the large pores and reduce the effects of rapid water flow in the soil (Barnard *et al*., 2010). Tagar *et al*.(2010) explained that when comparing the leaching method by continuous and intermittent spraying in silty clay soil, which was set up at the Biosaline Agriculture Center in Latif Experimental Farm in Pakistan after two months of leaching, that 46.1% of the salts were removed and to a depth of 0-60 cm below the leaching area, while it reached The percentage of salt leaching in the continuous spray system was 59.6%, and the distribution of salinity became homogeneous after leaching because the concentration of salts in the surface layer of the study soil was greater than the depth, as more salts were removed from the surface that accumulated in the depth of the soil, as these researchers suggested adopting a method Continuous spray as opposed to intermittent spray if time is a limiting factor for leaching. In a laboratory experiment carried out by Cherchian (2019) to study the effect of continuous and intermittent leaching method (immersion time 8 hours and rest period 16 hours) and

unsaturated water method (adding sand particles to the surface layer of soil to increase the water conductivity rate and allow unsaturated water movement) on the efficiency of salt leaching in soils The results showed the superiority of the intermittent leaching method in increasing the efficiency of leaching salts in the mixed soil, and adding water by the unsaturated method was the most efficient in leaching salts from the clay soil and that By removing 75% of the salt concentration from the soil and with the least amount of leaching water, while the different leaching methods did not record any significant effect in removing salts in soil with sandy texture. The researcher recommended using the continuous immersion method in leaching salts from sandy soil, especially when there is no availability Leaching water is a limiting factor in the leaching process. Under unsaturated soil conditions, a large part of the added water flows through small soil pores, thus reducing the amount of water flow in large or total pores and allowing more effective dissolution and leaching of the salts. In contrast, under saturated soil conditions, the movement of water from large pores. The small ones are limited by the lack of effective water transfer between the pores, which limits the transfer of salts from the exchange surfaces to the small pores (Callaghan *et al.*, 2017). Therefore, intermittent leaching is more efficient in reclamation because less irrigation water is used when water is added under unsaturated conditions to leaching salinity-affected soils. Tagar *et al.* (2007) indicated that due to the properties of the soil and climatic conditions, the intermittent leaching method proved to be more effective than the continuous spraying and immersion method even in the case of using lower quality water, as Tagar *et al.* (2010) showed that after leaching a clay mixture soil In the Biosaline Agriculture Center in Latif Experimental Farm in Pakistan for a period of two months, the continuous leaching method removed 61.59% of the salts from the soil bed (0-60 cm), while the intermittent leaching method managed to remove only 46.14% of the salts from the same depth. By continuing the leaching for a period of five months of experimental work, the intermittent leaching method showed a removal rate of 75.23% of the salts from the upper 60 cm layer, compared to 64.01% in the continuous leaching method, and 44% of the amount of leaching water consumed in the continuous immersion method was saved. Kanzari *et al.* (2012) showed that continuous immersion can certainly reduce the salinity content of the soil, but it also has a detrimental effect on the environment, as it requires a large amount of water, and excessive use of irrigation may lead to deep leaching of the added water and from It then increases the risk of salinization of the aquifer.

Shaygan *et al.* (2017) when studying alluvial mixture soil affected by the activities associated with oil extraction by leakage from a series of ponds containing brine in the Queensland region of Australia, the continuous leaching of soil columns led to the release of cations and a change in hydraulic properties during the reclamation of salts affected soil, This study indicates that the physical properties of the soil were changed in order to improve the conditions of the leaching and ion exchange process in the soil by using reformers: red gum from tree bark with an addition of 20% (w/w) and fine leached sand with an addition of 40% (w/w).), and bentonite with an addition of 2.5% (w/w), where the results indicated that the addition of bentonite can be used to achieve a greater decrease in exchangeable sodium (12.29 cmol $^+$ kg^{-1}) and magnesium (4.81 cmol $^{++}$ kg^{-1}) and a greater increase in calcium exchangeable (28.22 cmol^{++} kg^{-1}) which may be associated with a greater rate of cation exchange for this soil, and the hydraulic conductivity rate for all soil depths improved during leaching, which depends on the volume of cation exchange and then changes in the system Pores, this process reduced the water conductivity rate of the soil to which bentonite was added. The addition of bentonite is likely to be more efficient in reducing salinity, however low hydraulic conductivity requires conditions of constant and small water supply in the scrubbing process that may not be easy and achievable. A laboratory experiment was carried out by Al-Mansori (2018) to study the effect of water height in continuous leaching and intermittent leaching methods on leaching processes in sandy soil with electrical conductivity of 3.20 dSm^{-1} saturated soil paste from Hilla city using a deep water compressor (47.5 and 52.5). cm) from the Shatt al-Hilla River (0.37 dSm^{-1}) used in the leaching process, as the study indicates that the electrical conductivity rate of the soil decreases significantly with time, and then slows down until the end of the leaching process, and the same pattern can be seen for all the studied soil properties (acidity,

sulfates, suspended solids, chloride and calcium sulfate), as well as it was found that in continuous immersion a large amount of water is required over a short leaching period and vice versa for intermittent leaching, in addition to the decrease in all indicators of the study over time in continuous immersion compared to intermittent leaching , but when comparing the water level in the soil column, it can be concluded that increasing the height of the water column will reduce all soil indicators in both the continuous and intermittent leaching methods, where the study recommended that if time is the most important, it is better to use Continuous leaching lasts, but when water is limited, intermittent leaching can be the most economically feasible. In a study conducted in Brazil for the reclamation and leaching of mixed sandy soils carried out by Silva *et al*. (2019) using two leaching methods, continuous immersion and intermittent rinsing (a six-day rest period between irrigations) and five levels of salinity of the leaching water (2, 4, 6, 8 and 10) dSm^{-1}. The results showed that the best leaching system was intermittent leaching compared to continuous immersion, as the comparison of the leaching systems at each level of salt showed that the systems did not differ statistically for all salinity levels, where a gradual increase in the electrical conductivity rate of the study soil was observed with increasing levels of Salinity, which is attributed to the average soil texture.

6- Effect of the amount and quality of leaching water and leaching periods on the physical properties of soil:

In a study conducted in the Abu Ghraib area in Baghdad on silty clay soils to study the efficiency of leaching saline soils using saline water, Al-Qaisi (2000) noted that leaching salt-affected soils with saline water led to a severe decrease in the water conductivity rate for the final stages of leaching, and he attributed the reason for this To the leaching of fast-dissolving salts at the beginning of the leaching, followed by the displacement of less soluble salts, which led to closing the pores, and a decrease in the bulk density of the soil was observed with the increase in the salinity of the leaching water, and this was attributed to the formation of the pseudo-structure, as Al-Nabulsi (2001) studied the effect of salinity Water, leaching frequency and crop type in the physical properties of the soil. In his study in Saudi Arabia using three levels of salinity of irrigation water: water with electrical conductivity 3.50 dSm^{-1}, mixed water with electrical conductivity 7.90 dSm^{-1}, and sewage water with electrical conductivity 11.20 dSm-^{1}, and in a sandy mixture soil, where he concluded that the saline water caused a decrease in the water tip and the permeability of the soil, and that the values of the bulk density increased when using high salinity water for irrigation and that it decreased with depth, reaching 1.59 And 1.54 and 1.52 µg m^{-3} for depths of 10 - 0, 20 - 10 and 30 - 20 cm, while the total porosity of the soil decreased in the surface layer 0 - 10 cm compared to the other layers. In a study by Mahawish *et al*. (2003) on the relationship between the water conductivity rate, electrical conductivity rate and SAR and its impact on the efficiency of salt removal from brine saline soils in Anbar, they found that the water conductivity rate of sabkha soil at the beginning of leaching was 0.071 cm hour^{-1}, which is higher than in Al-Shora soil, which had a value of 0.044 cm h^{-1}, and they mentioned that the reason for this may be due to the presence of calcium ions in a higher percentage in the sabkha soil and its positive effect on inducing coagulation, as found by Tedeschi & Dell (2005) in A study was conducted to show the effect of irrigation with saline water at different concentrations on clay mixture soils in the Vitolazio region in Italy to evaluate the long-term effect of saline irrigation on crops and soil using three saline concentrations of irrigation water (0.25, 0.5 and 1% NaCl) and two irrigation levels. 100% and 40% of the evaporation-transpiration value), where the results showed a clear decrease in the stability rate of soil aggregates with the increase of soil salinity and the leach water used for reclamation, as a very large inverse relationship appeared between soil stability and the percentage of sodium Interchangeable (ESP) Whether sampling in fall or spring, fall and spring precipitation resulted in a severe reduction in soil salinity that failed to affect ESP as much as responsible for dispersal of soil aggregates, thus not forming soil structure for agricultural purposes. In a study conducted in Australia by Yadav *et al*. (2007) to evaluate the filtration efficiency of four different leaching methods (continuous leaching, spray leaching, continuous paper-covered leaching and intermittent leaching), where continuous leaching was applied in three soils with different water tip rate, While

spray leaching, leaching with paper covering and intermittent leaching were applied in the other three soil plots with a medium tip rate, the results showed that the rates of salt removal using the continuous leaching method tend to be higher near the soil surface with a lower tip rate, and that the spray leaching and continuous leaching The paper-coated and intermittent leaching are more efficient in removing salt than the continuous leaching, while the continuous paper-coated leaching and the intermittent leaching increased the horizontal homogeneity of the salt removal significantly. Continuous foliar leaching is an effective method for homogeneous removal of salinity from the soil. In a study carried out by Huang et al. (2010) to show the effect of leaching with different water types the electrical conductivity rate on the physical and chemical properties of alluvial mixture soil taken from the study site in the basin of Minqin region in northwest China, which was leached with saline water at a concentration of (0.8, 2 and 5 g l^{-1}) they found a decrease in the total porosity from 13.17% to 7.23% and the stability coefficient of soil aggregates at a rate of 4.75 - 2 mm at a depth of 0-20 cm from the soil surface by increasing the electrical conductivity rate of the leach water added during leaching, in addition to Increasing the electrical conductivity rate of saturated soil paste by 3.0 dS m^{-1}, especially at a depth of 60-90 cm, as shown by Pierera et al. (2019) in a study conducted in Brazil using electrolytic cells contained in a ceramic cylinder placed in polythene tubes to measure electrical conductivity using standard solutions of potassium chloride, the ability of soil drainage depends on the salinity of the leaching water, which faces great difficulties due to the use of large quantities of leaching water, especially with the aggravation of the scarcity of good salinity water due to leaching of sea water and various human activities.

A study was conducted by Chu et al. (2016) to show the effect of partial spraying of leach water on the properties of sandy, highly saline mixture soil in northern China using five types of intensities of leach water (1.7, 3.1, 5.3, 8.8, 10.1 mm h^{-1}) and five Amounts of added leaching water (148, 168, 184, 201 and 223 mm) and three time intervals between leaches (0, 24 and 48 hours), as the results of the study showed that increasing the amount of water and leaching periods contributed to reducing the salinity of the studied soil, especially in soil conditions. Unsaturated due to the improvement of water movement in the soil, as the results showed a decrease in the salinity of the initial soil (22.3 dm^{-1}) by 90% at a depth of 0-30 cm for all treatments, while the concentration of salts increased with depth 50-60 cm to reach 27.3 and 31.0, 38.5, 29.7 and 20.3 dSm^{-1} at discharge levels of 1.7, 3.1, 5.3, 8.8 and 10.1 mm h^{-1} respectively in the continuous immersion method, while in the intermittent immersion (24 and 48 hours), the results showed an increase in the efficiency of leaching Salts from the soil core studied by increasing the amount of added water and leaching the salts outside the soil core, and they also showed that it is possible to increase the leaching of the soil affected by salinity using m Leach water with low electrical conductivity and an increase in the amount of water added. A study was conducted in Isfahan in Iran by Javadi et al. (2019) to show the combined effect of irrigation and leaching administrations on the physical and chemical properties of sandy mixture soils, which included three types of leaching water (0.6, 3.0 and 6.0 dSm^{-1}) and three leaching periods (8, 45 and 100 days) and two leaching administrations included intermittent leaching (adding the leaching water when the soil reached 30% of the field capacity) and continuous leaching, where the results showed that the initial moisture content of the soil in the leaching treatments under continuous leaching was greater compared to the intermittent leaching, which It contributed to an increase in the water tip rate, and that the number of periods of wetting and drying caused the formation of the soil crust, which depended on irrigation management and the duration of leaching. With intermittent leaching contributed to its composition.

7- Effect of the amount and quality of leaching water and leaching periods on the chemical properties of soil:

Jalali & Ranjbar (2009) indicated a lower concentration of calcium in the drainage water during leaching and a higher ability of calcium to compete for adsorption in the exchange stage compared to magnesium, as the rate of magnesium concentration increased in the leaching water compared to calcium, and some types of soils have different behaviors in the leaching stages. While the concentration of magnesium in the drainage water of the mixed soils and clay mixtures decreased continuously until the last leaching stage compared to the sandy and sandy clay mixtures,

and alternately, it was noticed that the leaching directions increased and decreased to the eighth stage of the leaching process, after that it was noticed that the concentration was stable for all types of soils. At the end of the soil leaching process, both clayey and sandy clay mixtures showed the maximum leaching of magnesium which was recorded in the upper depths of the soil. In the leaching of magnesium, while it differed significantly from the sandy mixture soil, and there was no difference between all types of soils at the depth of 10-20 cm bass. Except for the mixed soils, soils of different textures did not show a significant difference in the leaching of magnesium at a depth of 0-10 cm.

In an experiment carried out by Jamali *et al.* (2012) to show the effect of leaching a silty clay mixture at Sindh Agricultural University in Pakistan using three water depths (7.62, 10.16 and 12.70 cm) and three time intervals between irrigations (7, 14 and 21 days) and it was found More than 40% of the surface layer salinity (0-60 cm) was removed by consuming 45.72, 60 and 76 cm of water for the period 7 and 14 days, while no significant difference was recorded for a period of 21 days, respectively, and this was attributed to the length of time Among the additions, the study recommended using 10.16 cm and 14 days as the best treatment for salt removal (56%) in the study soil.

Zeng *et al*. (2014) explained that the different amounts of irrigation have an effect on the concentration of salts in the soil, as the study showed that regardless of whether the leaching occurred once or intermittently (twice a day), the concentration of salts in the soil decreased for all depths with Increasing the amount of leaching water, which indicates the effect of leaching water in leaching salts from the soil. When the amount of leaching water was increased from 10 to 20 cm, whether after irrigation once or in the treatment of intermittent leaching, the concentration of salts in the soil decreased to depths 0-20 and 0 –40 and 0-100 cm by about 15.50, 13.58 and 5.70%, respectively. As for the increase in the amount of leaching water from 20 to 30 cm, the percentage of decrease in the concentration of salts from the soil varied and for different depths, reaching 2.3, 1.9 and 0.75 % when leaching once and 22.23, 19.44 and 11.59% for intermittent leaching successively, which proves the efficiency of intermittent leaching in leaching salts from the soil compared to leaching once.

The results of a reclamation experiment carried out by Hoseini & Delbari (2015) showed through a laboratory study conducted to show the effect of the leaching process on a group of saline-affected soils of different textures (mixture, sandy clay mixture, sandy mixture and clay mixture) in the sistan region southeast of Iran, the leaching was carried out in 10 stages using water Leaching with an electrical conductivity of 0.53 dSm-1 and with a quantity ranging from 0.25 to 5 volumes, which represents the volume of water retained by saturated soil in its pores. It decreased with the continuation of leaching to a minimum (5-8 mg L^{-1}) for all types of soil textures except for the sandy-clay mixture, which amounted to 13.7 mg L^{-1}, which was attributed to the presence of calcium in the leaching water as a competitor ion for sodium ion on the exchange surfaces, which It led to recording the highest initial concentration of sodium in the soil solution, which recorded decrease in the first stage of the leaching experiment and for all types of soil tissues, and the initial rise in the rate of sodium concentration in the leaching water was also observed in a study conducted by Jalali *et al.* (2008) in the Hamedan region, western Iran, who showed that the highest concentration of sodium in the leach water was recorded in soils with sandy clay and mixed sandy textures, than it was in the other two types, which was attributed to the low cation exchange capacity of light textured soil compared to soil Heavy texture due to the high percentage of large pores in coarse-textured soils compared to soft-textured soils, which leads to a relatively high amount of filtered water and then the removal of salts. The upper layer of the soil surface is 25.77 meq l^{-1} in sandy mixture, followed by sandy clay mixture (26.59 meq l^{-1}), then clayey mixture (29.71 meq l^{-1}), then soil mixture (34.85 meq l^{-1}), They also indicated that when leaching the soil with gradual amounts of irrigation water, it contributed to the leaching out of potassium from the study soil, as the maximum concentration of potassium in the leaching water was recorded at the beginning of the leaching process, then the concentration gradually decreased with the continuation of the leaching process. mixed soil and loamy mixture was lower than in sandy mixture and sandy

loamy mixture, as the concentration of potassium washed from mixed soil, sandy loam mixture, sandy mixture and clay mixture reached 42, 37, 32 and 28%, respectively, because heavy texture soils have the cation exchange capacity (positive ion exchange capacity) is higher compared to light-textured soils (Fageria, 2008), and this is due to the increase in the exchange surfaces in clay minerals compared to sand minerals, which increases the ability of clay particles to stabilize and exchange potassium. Concentration of washed calcium was recorded at the beginning of the leaching process for all types of study soils. In contrast to sodium and potassium ions, the highest concentration of leached calcium was recorded in heavy texture soils compared to liters. Its light texture, which reached in the first stage of leaching of mixed soils, sandy loam mixture, sandy mixture and clay mixture, was 35, 44, 33 and 42%, respectively. It was also noticed that more than 80% of the leached calcium from mixed soils, sandy mixture and clay mixture and 90% Calcium leached from sandy clay mixed soils was leached after the second addition of leaching water, and at the end of leaching the soil, it was noticed that calcium leaching was more in the upper layers of the soil surface in light textured soil compared to heavy soil soil, and no significant difference in calcium concentration was recorded. In the mixed soil and clay mixture, but they differed significantly compared to the other two types, the reason was attributed to the similarity in the type of tissue. At a depth of 0-10 cm, there was no significant difference between the calcium concentration in sandy and clayey mixture soils, but a significant difference was recorded from the other types, Also, no significant difference was observed between the mixed and sandy soils, while they differed significantly from the different types of soils at soil depth of 10-20 cm, but no significant difference was observed between the types of textures in Calcium was leached at a depth of 20-30 cm. It was also noted that the highest rate of magnesium ion leaching was recorded at the beginning of the leaching process and that the rate of magnesium washed at the beginning of the process in the mixed soil, sandy loamy mixture, sandy loamy mixture and clay mixture amounted to 37, 30, 34 and 43%, respectively.

Abdel-Fattah & El-Naka (2015) conducted a column experiment to determine the desalination and soda removal curves of saline-affected clay soils from Al-Tina plain in North Sinai in Egypt, to which natural gypsum, phosphogypsum and calcium chloride were added as requirements for reformers and calculated according to the equation of the US Department of Agriculture, which were mixed with soil at a depth of 30 The soil was leached using the intermittent leaching method by adding water to the columns of saturated soil, as the desalination curves showed that all treatments reduced soil salinity and soda with the superiority of calcium chloride in reducing soil salinity and soda, in addition, a standardized leaching estimate was adopted to show the effect of The sodium chloride removal curves showed that the addition of calcium chloride had a significant effect on the leaching rate values, which amounted to 0.39, 0.27, 0.25 and 0.19 to remove salinity and 0.35, 0.28, 0.27 and 0.16 to remove sodium for the comparison treatments, natural gypsum, phosphogypsum and calcium chloride, respectively. The lower values of the leaching rate in the calcium chloride treatment indicate the use of less water required for leaching and reclamation compared to the solution other malts. In a study conducted by Örs & Anapali (2016) to compare effective leaching strategies in removing and leaching salts from soil columns under laboratory conditions by adding 93 cm of water intermittently leaching in 5 periods of time, which was applied to light textured soil (sandy mixture) and medium texture (clay mixture), as the time between leaching periods was determined according to three different moisture levels according to the drying rates (15%, 30% and 45% of the field capacity), where the results indicated that there were significant differences between the different soil moisture levels at all depths, and that the best The salt leaching treatments are 45% of the drying moisture level for each of the light and medium soils, as 91.52% of the salinity of the light textured soil was leached out and 87.57% in the medium textured soil. In a laboratory experiment by Chu *et al*. (2016) to reduce the salinity of salinity-affected soil with a saline level of 22.3 dSm^{-1} by using five treatments to add leaching water (148, 168, 184, 201 and 223 mm) and with three leaching periods (0, 24 and 48 hours) through the drip irrigation system , they found that the salinity of the soil decreased with the increase in the amount of leaching water at the 48-hour leaching period to reach 15.7, 14.4, 13.9, 13.1 and 12.6 dm^{-}

[1], respectively. They also indicated that the salinity increased with increasing soil depth to reach an average of 20.3 and 27.3, 29.7, 31.0, 38.5, and dsm-1 at depth 50-60 cm respectively. Díaza *et al*. (2018) indicated a high salt leaching efficiency of saline-affected clay soil taken from the island of Lanzarote in Spain and irrigated with water with electrical conductivity of 2.5, 5.0, 7.5 and 10.0 dSm^{-1} to reach an average of 12% compared to the control treatment (0.4 dSm^{-1}), which recorded soil salinity amounting to 2.1 dSm^{-1}, as the soil salinity decreased to 12.6, 16.8, 19.1 and 19.3 dSm^{-1}, respectively, compared to the initial salinity of the soil (54 dSm^{-1}), and the study also showed an increase Significant in the concentrations of the exchange elements (sodium, calcium and magnesium) for the above treatments compared to the initial concentrations of the soil studied.

In an experiment by Pierong *et al*. (2019) conducted in the main laboratory of irrigation, sanitation and agricultural soil and water environment, with the aim of leaching saline-affected alluvial mixture soils in the unreclaimed coastal area in eastern China using maize straw that was added at two depths (80 and 100 cm) from the soil surface and leaching water using sea water diluted by volume by 25% (14.38 dSm-1) and 50% (6.62 dSm^{-1}), in which the leaching process was repeated every three days, where the electrical conductivity rate of the soil was measured at depths 10, 30, 50 and 60 cm, where the results indicated a positive correlation between the efficiency of salt leaching and the increase in the amount of leaching water. A rest period of 6 days was recorded for the treatment, while the lowest efficiency was recorded for the treatment of 30 days.

8- The relationship of the standard of leaching and the requirements of leaching with the efficiency of leaching salts:

The leaching efficiency means the amount of dissolved salts that can be removed per unit volume of the added water (Tanji, 1990), and one of the most important basic ingredients for the success of the process of reclamation of saline soils is to determine the optimum amount of leaching water or the so-called (leaching norm), which is meant the volume of water needed to reduce the salt concentration to the extent that does not interfere with the effective depth of the root zone of the plant (Ismail, 2000). Irrigation water contains dissolved salts in it and the crops consume almost pure water for transpiration (some of the salts specified by the roots are taken as nutrients), and then the concentration of salts occurs in the root area, and increasing the salts within the root area requires periodic leaching to remove the amount of accumulated salts down to avoid reduced crop yields and deterioration of soil properties (Letey *et al*.;2011).

Leaching Efficiency (L.E.) Calculated from the equation from Dielman (1963) :

$$L.E. = (ECd / ECs) * 100 …………..(1)$$

Where L.E. = leaching efficiency.

ECd = electrical conductivity rate of drainage water (dSm^{-1}).

ECs = electrical conductivity rate of soil water (dSm^{-1}).

Hoffman proposed an equation (1980) for the salt transport efficiency under one-dimensional leaching :

$$k = (C/Co) (D/Ds) ………(2)$$

where C is the salt concentration in the soil, Co is the initial salt concentration in the soil, D is the depth of leaching water applied, Ds is the depth of the soil to be leached, and k is an empirical coefficient that reflects the differences in saturated volumetric water content and leaching efficiency among soil types. Coarse textured soils have a low water content and high leaching efficiency under continuous ponding with k = 0.1, whereas the reverse is true for finer textured soils (k = 0.3).

According to Barnard (2010), an exponential type of function is also very suitable to describe the relationship of salt removal by leaching as a function of drainage water. A re-parameterized version of this exponential function is applied in this paper:

*C/C0 = Feq. + (1 - Feq.) * exp [- ε / (1 - Feq.) * (Dw / Ds)]* (3)

Where *C/C0* is the fraction of the initial salt concentration remaining in the soil profile after application of the amount of water per unit depth of soil *Dw/Ds*. The advantage of this formulation lies in the particular meaning assigned to its parameters: *Feq*, is the equilibrium (or asymptotic) salinity fraction value, while ε is the initial leaching effectiveness (the water leaching capability just at the beginning of the process), geometrically corresponding to the initial slope of the curve.

The use of irrigation water of low salinity to maintain soil salinity at levels at which maximum crop productivity can be obtained by adding additional water to drain through the root zone and then removing excess salts in the root zone, and the lower the portion of the applied water that becomes drainage water, the greater the average root zone salinity, and the additional water required to maintain the soil salinity level is called the leaching requirement (McCualey; 2005).

Letey *et al*.,2011 showed that irrigation scheduling is usually based on the calculation of evapotranspiration is the potential for adding a constant amount of additional water supply to leaching, and the typical leaching requirement (LF) used by researchers ranges from 15% to 20% depending on soil texture and other environmental conditions. The relationship between the amount of added water (AW), ET and LF is shown in the following equation:

AW / ET = 1 / (1 - LF)............................. (4)(Ayers and Westcot ,1985)

Where AW = depth of water added (mm season^{-1})

ET = total crop water consumption (mm)

The 20% leaching requirement requires that the value of (AW/ET) be equal to 1.25, which requires the addition of 25% of the additional water supply and above the evapotranspiration factor of crops to obtain 20%, while the leaching fraction is calculated from the following equation:

L.F = drainage volume (Vd) / irrigation volume (Vi) ……(4)(US Salinity Laboratory Staff, 1954)

Several field studies showed that intermittent leaching is more efficient in terms of water use and solute movement than continuous leaching (Dahiya *et al*., 1981; Addiscott & Rose, 1978; Oster *et al*., 1972; Miller *et al*., 1965), which is attributed to To the fact that the soil is drier when rest periods are used between irrigations, the water flows through the micro-pores more efficiently and allows for a more efficient exchange of brine (Hoffman, 1980). The principle of alternating wash-water addition can be effectively used to control soil bed wetting during the scrubbing process. According to Cote *et al*.(2000) the scrubbing efficiency can be increased on a field scale by using dry periods in intermittent scrubbing by evaluating the amount of water supplied to wash the quantity certain solute.

Also noted by Mostafazadeh *et al*. (2007) when studying the effect of irrigation water salinity and different levels of leaching on some chemical properties of clayey alluvial mixture soil in Isfahan region in Iran using three salinity levels of irrigation water (4, 9 and 12 dSm^{-1}) and four ratios of leaching requirements (0 and 17) and 29 and 37%) decreased the efficiency of salt leaching by increasing the salinity of the irrigation water, and adding the leaching requirements at levels 0, 17, 29 and 37% with irrigation water with an electrical conductivity rate of 4, 9 and 12 dSm^{-1} had a role in the distribution of salts during The clayey alluvial mixture soil sector in the dry areas, the best treatments were at the level of leaching requirements 37% and the salinity of irrigation water 4 dSm^{-1}, which reduced the salinity of the initial soil by 56%, and the increase in the salinity of irrigation water or the levels of leaching requirements led to an increase in salinity The saturated soil paste extract, the salinity of irrigation water of 12 dSm-1 caused the greatest salinity of the soil at the end of the season, and the salinity of irrigation water 9 and 4 dSm^{-1} led to a decrease in soil salinity of 34% and 68%, respectively, while it was recorded Leaching requirements 17, 29 and 37% Decrease in soil salinity 38 and 55 and 65%, respectively, compared to the treatment with no leaching requirements added (0%).

Ahmadi *et al*. (2010) showed that the leaching efficiency increases with the increase in the leaching periods in the intermittent leaching method due to the increase in the solubility of salts from the soil, as drying the surface layer during the rest period between irrigations improves the entry and movement of water added in the subsequent irrigation, which contributes to Melting and movement of salts in the subsequent irrigation, Mahmoud (2012) also indicated an increase in the efficiency of the leaching water with an increase in the number of irrigations of brackish water, Leaching curves represent a very good way to determine the leaching efficiency and optimal depth of leaching water needed to reclaim saline and soda soils, however the leaching constant value depends mainly on soil properties, depth of soil to be reclaimed, initial salinity concentration, quality and quantity of leaching water, and applied leaching method (intermittent or continuous). The type of chemical reformers added, the speed of dissolution, and the physical and chemical

properties of the soil, so the leaching constant is a useful tool to determine which amendment is the most suitable and economically acceptable for soil reclamation considering the prevailing local soil characteristics and agricultural conditions (Abd-fattah & El-Naka, 2015).

Saleh & Muhammad (2011) found when studying the moisture distribution and salt concentration in a loamy alluvial soil (7.31 dSm^{-1}) planted with maize at Al-Raed Research Station in Abu Ghraib in Iraq after 48 and 72 hours of surface and sub-surface drip irrigation concluded that the amount of water The low salinity added according to treatments 40, 60 and 80% of the field capacity with the addition of 15% leaching requirements, led to a reduction in the salinity level after planting and for all treatments, and the electrical conductivity rate values were 7.33, 6.39 and 5.11 dSm^{-1}, respectively, for the above treatments.

9- The effect of agriculture, irrigation and leaching requirements on soil properties and plant growth after reclamation operations:

The amount of water added and the time required for soil reclamation depends on the depth of the soil to be reclaimed, the initial salinity, the type of salts present, and soil properties such as texture, structure, leaching and permeability. cm of soil depth, which varies according to soil type (Mostafazadeh-Fard *et al*., 2008).

Al-Hadithi & Al-Heti (2010) indicated that the use of 15% and 25% leaching requirements led to a significant decrease in the concentrations of sodium, potassium, calcium, magnesium, sulfate and chloride ions in the maize root zone, and adding 15% leaching requirements significantly increased the dry weight values of maize roots. In addition, the lengths of roots increased when leaching requirements were added at a level of 15% compared to the level of 25%.

In an experiment conducted at the Soil and Water Resources Center research station in Baghdad by Attia *et al*. (2013) to show the effect of adding leaching requirements to a clay mixture in order to determine the most appropriate type and level of addition to leaching requirements and its effect on the growth and yield of maize using two types of leaching water (conductive river water). Electricity 1.4 dSm^{-1} and well water with electrical conductivity 4.2 dsm^{-1}), two levels of leaching requirements (20% and 40%) and two ways to add leaching requirements (continuously with each irrigation or in the form of two batches during the growing season of the crop: the first at the beginning of season and the second after 50 days of planting), where the results showed a decrease in the yield of eagles by about 14% when adding leaching requirements in two batches (the first at the beginning of the growing season and the second after 50 days of the first addition) and at the level of adding 40% of the leaching requirements to irrigation water With a salinity level of 4.2 dS m-1 compared to river water with an electrical conductivity of 1.4 dSm^{-1}, the results also showed an increase in the salinity of the surface layer (0-60 cm) by 3.7 times when irrigating with water with an electrical conductivity of 4.2 dSm^{-1}. Without adding measurement leaching requirements the salinity of soil irrigated with water with electrical conductivity was 1.4 dSm^{-1}, while a decrease in soil salinity was achieved by 30 and 43% when using 20 and 40% leaching requirements, respectively, compared to the same treatment irrigated with the same salinity of water and without leaching requirements.

Al-Shammari & Hamza (2013) also showed that the use of leaching requirements of 15 and 25% on alluvial clay soil in the district of Hit in Anbar using mixed saline irrigation water (3 dSm^{-1}) from well water of 5.83 dSm^{-1} and Euphrates river water of 1.07 dSm^{-1} with three levels of leaching requirements (0%, 15% and 25%), which led to a decrease in the concentration of positive and negative ions in the surface layer of the soil and an increase in their concentration in the subsurface layers, where the total positive ions reached 5.81, 7.14, 7.55 and 10.86 meq L^{-1} to treat the leaching requirements of 15% and for depths (0-30, 30-60, 60-90 and 90-120) cm respectively, and when the leaching requirements were increased to 25%, the total positive ions became 4.51, 6.84, 7.25 and 13.5 meq L^{-1} for the same depths and successively. They also indicated an increase in the total production of maize yield to reach 11.32 and 10.50 tons h^{-1} respectively compared to the no-addition treatment, which amounted to 10.27 tons h^{-1}.Leaching compared to treatment of 15% leaching requirements to the negative effect of salinity due to an increase in osmotic potential As a result of the ionic effect, as the increase in salinity leads to a competitive effect between the

absorption of ions.As for the decrease in total production at the level of 25% leaching requirements, it may be due to the increase in the amount of added water by 25% more than the actual need of the crop, which affected the leaching of the main nutrients (Nitrogen, phosphorous and potassium) that the plant needs for growth and thus affected the productivity of the crop.

CONCLUSIONS

1- The process of reclamation of salinity-affected soil by intermittent leaching method by reducing the time period between leaching and good quality leaching water contributed to reducing both the electrical conductivity rate of the soil during the leaching stages and the concentrations of positive and negative ions significantly in the soil solution and the effect on the efficiency of salt leaching in the soil, as well as the effect on some Physical properties of salinity affected soils.

2- Intermittent leaching processes with all their factors affect the chemical and physical properties of the soil by reducing the electrical conductivity rate of the soil, increasing the bulk density, decreasing the weighted diameter rate, and the low saturated water conductivity rate of the soil, as well as the growth and productivity indicators of the cultivated crops after the reclamation and leaching process, where the presence of plants is a major support in the process of Reclamation, as well as the contribution of the process of culturing the reclaimed soils and according to the type of crop in improving the physical and chemical properties of soils, thus enhancing the growth indicators of plants and increasing productivity.

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غسل واستصلاح الترب المتأثرة بالملوحة وتأثيرها في خصائص التربة ونمو النبات

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الخلاصة

تعاني الترب المروية في المناطق الجافة وشبه الجافة من مشكلة تراكم الاملاح فيها لعدم استعمال ماء غسل كافي لازالة الاملاح المضافة مع مياه الري. ان ملوحة التربة تساهم في انخفاض نمو وانتاجية النباتات النامية في تلك الظروف، وكذلك التاثير في خصائص التربة الفيزيائية والكيميائية والهيدروليكية. تعد عملية الاستصلاح الحل الجذري لمشكلة التملح ومن أهم المقومات الاساسية لانجاح عملية إستصلاح الترب الملحية هو تحديد الكمية المثلى من مياه الغسل أو ما يطلق علية (مقنن الغسل). ومن ثم فان عملية الغسل وصافي حركة مياه الغسل مطلوبة لإزالة الأملاح لمنعها من التركيز في منطقة الجذور إلى المستوى المناسب لتحمل النباتات لضمان عدم تاثيره في نموها وانتاجيتها. ان مفهوم غسل لتربة من الاملاح وتحسين خصائصها الفيزيائية والكيميائية يعتمد على عدة عوامل منها متعلقة بطريقة الغسل وملوحة وكمية الماء المضاف خلال عملية الغسل والفترة الزمنية للغسل فضلا عن خصائص التربة وعوامل أخرى، اذ بين كثير من الباحثين تفوق طريقة الغسل المتقطع بالاحواض قياسا بالغسل المستمر في إذابة الاملاح الموجودة في الطبقة السطحية وانتقالها مع حركة الماء الى الاعماق ومنه الى اماكن البزل، كما اشاروا الى ان زيادة فترات الغسل ذات ملوحة ماء غسل منخفضة في طريقة الغسل المتقطع اظهرت كفاءة اكبر في استخدام كميات أقل من المياه، اضافة الى ان زيادة فترات الغسل قد تزيد من سرعة غسل الاملاح من التربة كذلك أشاروا الى ان زيادة كمية المياه وفترات الغسل قد تساهم في خفض ملوحة التربة المدروسة وخاصة في ظروف التربة غير المشبعه.