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The causes and degree of salinization of Iraqi lands and the possibility of treating them biologically (Article review)

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ABSTRACT

The problem of salinization of agricultural lands in Iraq is one of the main problems that led to the deterioration of the agricultural sector, and the high levels of salinization in the soil not only means the loss of more agricultural lands, but also a decrease in its productivity. Reports indicated that 60-70% of the lands in central and southern Iraq It was affected by salinity and became outside agricultural exploitation, and the agricultural expansion horizontally and vertically in Nineveh Governorate led to the transformation of demi-cultivating into irrigated agriculture for most areas of the governorate. However, the agricultural misuse and waste in water use turned most of the soils into areas affected by salts.In order to improve plant growth and agricultural production in salt-affected soils, excess salts must be removed from the root zone. As for the commonly used methods for the reclamation of these soils, they are the scraping of salts from the surface, which are suitable for soils with little permeability, and washing using large quantities of water with cultivation, and taking into account that saline soils prevail in arid and semi-arid regions, in addition to the scarcity of water in these areas, in addition to the costs exorbitant this method is considered useless, and recently there has been increased interest in using modern technologies to treat the problems of soils affected by salts and through the concept of auxiliary plants (plant – assisted concept) within the method of phytoremediation, which includes growing plants capable of collecting salts and harvesting them in order to rid them from the soil In addition to the possibility of irrigating it with salty water due to the scarcity of fresh water.

***Keywords*:** Ornamental plant, Hippeastrum vittatum; Self incompatibility; Ornamental bulb breeding programs.

INTRODUCTION

Soils affected by salts are spread in different climatic regions of the world, especially arid and semi-arid regions, including Iraq, as reports indicated that 60-70% of the lands of central and southern Iraq were affected by salinity and became outside agricultural exploitation Also that agricultural expansion is horizontal and vertical in Nineveh Governorate has led to the transformation of rainfed agriculture into irrigated agriculture for most areas of the governorate, however, the agricultural misuse and waste in the use of water has turned most of the soils into salt-affected ones, especially in the Northern Jazeera irrigation project, as a result of the use of water of different quality (Tigris River water, drainage water and salty wells water What exacerbated the problem is the lack of Each the management of these projects and the maintenance of drainage networks in a good way and also the use of irrigation water more than the need of agricultural crops which led to a rise in groundwater levels and its proximity to the surface of the soil on the one hand and a rise in summer temperature more than (50 ° C) and fluctuations Climate, especially periods of precipitation and its fluctuations, on the other hand, contributed significantly to soil salinization [1], and that the ecosystem in saline soils is not only affected by the increase in the concentration of dissolved salts, which is accompanied by its content of dissolved and exchanged ions in particular [2]. The difference in the balance of ions in the liquid and solid soil phases leads to the formation of saline soils or the increase in sodium, the development of alkalinity, and the formation of saline-sodic soils. Therefore, we must manage these types.

of soils to prevent the return of salts to them again [3], and the salinization of the soil depends agricultural (geological composition of parent material, water salinity, wind-borne salinity, decreased precipitation, and increased evaporation rate) and human activities (surface irrigation with saline or groundwater, inadequate irrigation management practices, poor drainage and overgrazing of rangelands, vegetation cover) [4].

The problem of salinization of agricultural lands in Iraq is one of the main problems that led to the deterioration of the agricultural sector, and the high rate of salinization in the soil not only means the loss of more agricultural lands, but also a decrease in its productivity ،in which farming is impossible. This problem has also received global and local attention from both theoretical and practical perspectives, and the mechanisms of salinization and leaching from the physical and chemical sides [5]. Sewage water and Groundwater [6].

Salinity problem in Iraq in the past

Based on much historical evidence and scientific facts, the first agricultural revolution in the life of mankind took place in the north of the Mesopotamian Valley. This period dates back to about (6000) years BC, and the transformation of man in this era of history and this part of the world from a collector of food to a producer It has the first start in the history of the world to use irrigation water in agriculture in the south of Mesopotamia, about (4500) years BC, which is the same period in which the beginning of the salinization problem was recorded in the south of Mesopotamia [7].

Table (1) Grain yield in different ancient periods in the lands of Al-Zubaidi, (1989)

Period (epoch) time	The gotter kg ha^{-1}	rate Wheat: barley	Notes
3600 years B.C.E.	---	1:1	
2500 – 2400 B.C.E.	2500	1:6	The first document refers to Salinity problem in southern Iraq
2000 years ago Birth	1640	Wheat makes up 2%	
1800 years ago Birth	897	Wheat does not form Rate	Indication of a salinity problem

Salinity problem in Iraq at present

The problem of salinity at present is one of the important problems in agriculture in Iraq, especially in the center and south. If we exclude the desert areas in the west and south of the country, which constitute (50%) of the area of Iraq, as well as some areas of northern Iraq above the rain line (400-500) mm, we find that most of the arable land in Iraq is affected by salts. And based on a map developed by [8] for the distribution and spread of saline and sedimentary soils, it was concluded that about 75% of the lands of central and southern Iraq are affected to different degrees by salinity. The latest data from the International Food and Agriculture Organization [10] indicate that approximately 60% of the agricultural lands were seriously affected by salinity, and 20-30% were left. Even the cultivated lands, their yield decreased by 30-60% due to salinization.

Degree of soil affected by salinity in Iraq

A detailed and extensive soil survey was conducted in Iraq from 1955 to 1985.

The results of this study reveal that most of the soil types are saline, and most of them are highly saline, and that large areas are outside the scope of production [9]. The survey estimates indicate that even if all the salts could be washed out from the upper few meters (surface layers) of the soil, 20% of the Mesopotamian soils would be of good productivity, 40% would be medium productive, and 40% would be marginal lands. (low productivity) [10].

Later, an inventory of soil salinity in selected projects published by [11] showed that the high salinity of the soil of projects in northern Baghdad is higher than 8 dS m^{-1} in 35–50% of the area, and higher than 16 dS m^{-1} in 15 - 25% of the area. Projects in southern Baghdad show that soil salinity in more than 80% of the project area is greater than 18 dS m^{-1}, estimates of the seventies reveal that about 20 to 30 percent of the cultivated area is affected by salinity of various levels, which resulted in reductions in yield production reaching 20 to 50% in this soil. Recently, the Food and Agriculture Organization, 2011) prepared a map of Iraqi land salinity, which shows the degree of soil salinity, Figure 1.

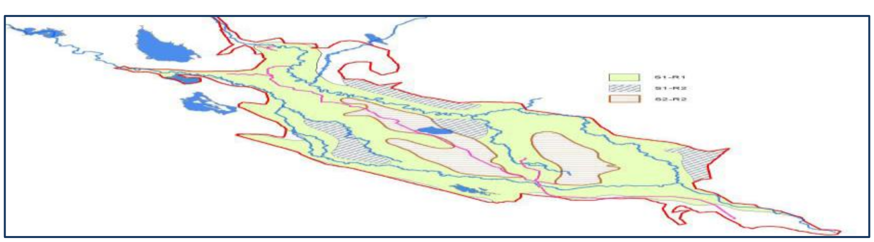

Figure (1) Mesopotamia Plain Soil Degradation Rate (FAO, 2011)
S1• indicates that soil salinity levels were between (4 - 15) dS m^{-1}.
S2: indicates that the soil salinity was greater than (15) dS m^{-1}.
R1* indicates that soil salinity was increasing by (2 – 3) dS m^{-1}.

R2• indicates that soil salinity was increasing by (3 – 5) dS m^{-1}

Causes of soil salinization in Iraq

1- Intensive irrigation uses more irrigation water than is needed for agricultural crops.

2- Farmers commonly used the irrigation method of flooding basins for long periods before switching to modern irrigation methods. Farmers are ignorant of the actual need for water to irrigate crops, and the amounts of irrigation water they use are usually based on their local experience or plant conditions, such as soil dryness or stiffness of plant leaves.

3- The high groundwater level and consequent salinization of the soil are long-term problems for the regions of central and southern Iraq.

4- Using groundwater or tap water that contains high concentrations of salts, especially in areas that suffer from a scarcity of irrigation water [12].

5- The high concentration of salts in the Tigris and Euphrates rivers. The salinity of the Tigris River increases from (0.44 dS m^{-1}) at the Turkish-Iraqi border to more than (3 dS m^{-1}) in Amarah Governorate (southern Iraq), and from (1.3 dS m^{-1}) of the Euphrates River in the Syrian-Iraqi borders to (4.6 dS m^{-1}) at the time it reaches the Shatt al-Arab.

6- Most of the drilling projects were built 40-50 years ago, and due to obsolescence and poor maintenance, most of them were abandoned or out of service.

7- Low rainfall and high evaporation as a result of hot and dry climatic conditions are another major cause of soil salinity in Iraq [13].

8- Excessive grazing in the pastures, which leads to exposure of the soil, which is a great danger that causes salinity.

9- Poor settlement.

10- Soil evaporation in summer due to shallow saline groundwater.

11- Excessive use of heavy mechanization, which causes soil compaction and poor permeability [14].

Soil salinity treatment methods

One of the common issues is that in order to improve plant growth and agricultural production in salt-affected soils, excess salts must be removed from the root zone. As for the commonly used methods for the reclamation of these soils, they are the scraping of salts from the surface, which are suitable for soils with little permeability, and washing using large quantities of water with cultivation, and taking into account that saline soils prevail in arid and semi-arid regions, in addition to the scarcity of water in these areas, in addition to the costs exorbitant, this method is considered useless, and recently there has been increased interest in using modern technologies to treat the problems of soils affected by salts and through the concept of auxiliary plants (plant – assisted concept) within the method of phytoremediation, which includes growing plants capable of collecting salts and harvesting them in order to rid them from the soil. In addition to the possibility of irrigation with salt water due to the scarcity of fresh water [15].

How long does this technology take to reclaim soil??

Phytoremedation consists of two words, the first Phyto, meaning plant, and the second Remediation, meaning reclamation or treatment, to describe a technique whereby some plants, along with living organisms in the soil, convert humans and environmental harmful pollutants into harmless forms, and in many cases useful, this technique is now being used increasingly to remediate salinity-affected sites, contaminated with heavy metals, toxic organic compounds and radioactive materials. Phytoremediation technology takes advantage of a plant's nutritional system, which is built on uptake of water and nutrients through roots, leaching of water through leaves, or metabolism of organic compounds such as oil and pesticides, or it may absorb and bioaccumulate toxic trace elements and heavy metals lead, cadmium and selenium [16].

The treatment of contaminated sites using traditional methods is often expensive, has limited efficiency, and applies to small areas. In addition, traditional methods often make the soil unsuitable for agricultural use, and do not solve the problem in practice. For example, in Germany, traditional cleaning facilities contribute to cleaning 30% of the soil in the polluted sites. In contrast, the remaining soil is stored in waste disposal facilities, and this does not solve the problem from its roots, but is sufficient to transfer it to subsequent generations, so there is an urgent need to develop methods an environmentally friendly, cheap and effective alternative to cleaning polluted industrial areas that takes into account the potential end use of the soil after it has been cleaned. This is because it does not destroy the treated soil, as it can be used for cultivation after cleaning [18].

1- Is this method economically feasible compared to traditional methods?

In this mechanism, pollutants are adsorbed, absorbed, or precipitated by the roots in the root zone of the plant. This mechanism is similar to extraction, except that it is used to clean groundwater, while the extraction mechanism is used to clean the soil. Plants are grown in polluted water, or polluted water is pumped to plants cultivated that draw polluted water. When the plant becomes saturated with pollutants, it is harvested. An important application of this mechanism is the use of sunflowers to treat the radiation-contaminated water pools that resulted from the Chernobyl reactor explosion in Ukraine. [17].

2- How much salt can be eliminated using these methods?

In this mechanism, certain types of plants are used in order to mechanically stabilize the contaminated soil, to prevent the movement of pollutants in the soil or groundwater due to erosion factors or air, and to reduce their transmission to other environments, especially the human food chain. This mechanism includes the absorption of pollutants and their accumulation in the roots or their adsorption on the roots. Or deposited within the root zone of the plant. This technique is often used to regenerate vegetation in sites where the soil deteriorates due to the high concentrations of heavy metals [19].

3- phytodegradation:

In this mechanism, plants and their associated microorganisms degrade organic pollutants in plant tissue, such as munitions waste, polychlorinated bisphenols (PCBs), and some chlorinated solvents.

The success of this process requires bioavailable organic pollutants for uptake and metabolism by plants and their associated microorganisms. The degree of bioavailability depends on the complexity of the pollutant composition, age, and soil type. Poplar trees have been used in multiple applications by this mechanism of catabolism of toxic and stubborn organic compounds [20].

4- Phytovolatilization:

This mechanism includes the absorption and transpiration of organic pollutants by plants, where the plant absorbs pollutants from the soil or water and subtracts to the air (evaporation), and plants that have a high rate of evaporation and transpiration are usually used. The more volatile pollutants are easier to treat with this mechanism. For example, volatile organic compounds (VOC) can be efficiently treated in this way. With developments in genetic engineering, this method could be used to remove mercury from polluted environments, whereby (ionic) mercury is converted to less toxic metallic mercury and vaporized into the air.

In some applications, metals such as selenium, arsenic, and mercury have been converted into organic compounds (such as metal) to facilitate their biological handling [21].

Halophytes

The botanical dictionary defined halophytes as plants that have adapted to live in soils that contain high concentrations of salts, and halophytes are plants that can withstand monovalent ionic concentrations of more than 70 mmol/L. Recently, halophytes were classified as plants that complete their life cycle in saline conditions equivalent to 200 mmol sodium chloride. The degree of tolerance of plants to salinity varies from one type to another. The cut-off depends on the extent to which plants benefit from important concentrations of sodium chloride, or not, while sodium is an unnecessary element for plants. However, it stimulates the growth of many halophyte plants, and their growth is ideal in the presence of sodium chloride. Sodium is also an essential micronutrient for a number of wheat species [22].

Distribution

Halophyte plants grow in a wide variety of saline environments ranging from warm to arid and semi-arid regions, from coastal dunes to salt inland deserts, wet and saline inland areas and finally salt marshes. These plants rehabilitate dry areas because they are adapted to environments with low annual rainfall (150-200 mm/year). The lower limits of halophyte spread in saline environments are environmental physicochemical factors, such as salinity tolerance and waterlogging. Competition is the main factor determining the upper limits of plant spread in non-saline environments with low moisture content. The more salinity-tolerant halophytes are either less competitive in non-saline environments or have compulsive salt requirements that prevent them from growing in freshwater marshes [23]. Halophyte plants are divided into several groups or species according to the method of acclimatization to salinity.

Combined halophytes for salts:

This group includes the most salt-resistant halophytic plants. The cells of these plants are permeable to salts and can accumulate large quantities inside their bodies [24].

Halophites that can release salts:

The plants of this group can grow in conditions of low and high salinity, and the protoplasm of the cells of these plants is characterized by its high ability to permeate to salts. However, this group also can pronounce or get rid of salts by means of a special number These cells that spreads on the surface of the leaves or the body of the plant, or through the fall of the leaves in which a large amount of salts has accumulated. Some of them have the ability to get rid of the salts by the root cells [25].

Salt impermeable halophytes:

The plants of this group usually grow in conditions that are not high in salinity. The cells of the plants in this group are considered less permeable to the passage of salts or less permeable to salts. They resist high osmotic pressure by raising the osmotic pressure inside their body due to the accumulation of metabolic products such as carbohydrates [26].

Locally collected halophytes for salts:

The surface and appearance of the plants can be listed as follows: These plants have the ability to collect salts in sites or parts of their bodies when they grow in saline conditions. For example, the accumulation of many salts in hairs, especially the upper and lower surface of the leaves, like a plant *Atriplex* and *Salicornia* [27].

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اسباب ودرجة تملح الاراضي العراقية وامكانية معالجتها بايولوجياً(مقالة مراجعة)

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الخلاصة

تعتبر مشكلة تملح الأراضي الزراعية في العراق من المشاكل الأساسية التي أدت إلى تدهور القطاع الزراعي، كما أن ارتفاع مستويات التملح في التربة لا يعني فقط فقدان المزيد من الأراضي الزراعية، بل يعني أيضاً انخفاض إنتاجية. أشارت التقارير إلى أن 60-70% من أراضي وسط وجنوب العراق تأثرت بالملوحة وأصبحت خارج الاستغلال الزراعي، كما أدى التوسع الزراعي أفقياً وعمودياً في محافظة نينوى إلى تحول الزراعة الديمية إلى زراعة مروية لأغلب المناطق في المحافظة، وأن سوء الاستخدام الزراعي والهدر في استخدام المياه جعل معظم الترب متأثرة بالأملاح.من أجل تحسين نمو النبات والإنتاج الزراعي في التربة المتأثرة بالملوحة، يجب إزالة الأملاح الزائدة من منطقة الجذر. أما الطرق الشائعة لاستصلاح هذه الترب فهي كشط الأملاح من السطح وهي مناسبة للترب قليلة النفاذية، والغسل باستخدام كميات كبيرة من الماء مع الزراعة، وبما أنه الترب الملحية تسود في المناطق الجافة وشبه الجافة، بالإضافة إلى شح المياه في هذه المناطق، بالإضافة إلى التكاليف الباهظة، وتعتبر هذه الطريقة غير مجدية، وفي الآونة الأخيرة زاد الاهتمام باستخدام التقنيات الحديثة لعلاج مشاكل التربة المتضررة بواسطة الأملاح ومن خلال مفهوم النباتات المساعدة ***(plant – assisted concept)*** ضمن أسلوب المعالجة النباتية والذي يتضمن زراعة نباتات قادرة على جمع الأملاح وحصادها بهدف تخليصها من التربة بالإضافة إلى إمكانية ريها بالمياه المالحة بسبب ندرة المياه العذبة

الكلمات المفتاحية: ملوحة التربة، المعالجة البيولوجية، النباتات الملحية، المياه المالحة.