Int. J. Agricult. Stat. Sci. Vol. 17, No. 1, pp. 63-72, 2021 www.connectjournals.com/ijass
DocID: https://connectjournals.com/03899.2021.17.63 ISSN : 0973-1903, e-ISSN : 0976-3392

ORIGINAL ARTICLE

THE EFFECT OF ALTERNATING SALINITY OF IRRIGATION WATER AND CULTIVATION LEVEL ON SOME SOIL PROPERTIES AND GROWTH OF DATE PALM (*PHOENIX DACTYLIFERA* L.) OFFSHOOTS OF HILLAWI CULTIVAR IN CLAY SOILS

Abdulrahman Dawood Salih Al-Hamad[1], Mohammed Abdulameer Hasan Alnajjar[2] and Majid Abdulhameed Ibrahim*

[1]Date Palm Research Center, University of Basrah, Basrah, Iraq.
[2&*]Faculty of Agriculture, University of Basrah, Basrah, Iraq.
E-mail: majid.abdulhameedl@uobasrah.edu.iq

Abstract: The study was conducted in one of the palm orchards in the Abi Al-Khasib district, 20 km south of Basrah governorate for the 2018-2019 agricultural season in soil with a clay texture to study the many problems facing the cultivation of date palm offshoots that are affected by salts, and for the purpose of reducing the failure and death of these offshoots during the early stages of cultivation, and to legalize the use of freshwater in the Iraqi southern regions due to water scarcity and the decrease in water resources there. The research included the use of two factors, the saltwater and freshwater alternation factor, and four alternating levels were used in a triple cycle: freshwater - saltwater - freshwater (FSF), freshwater - freshwater - saltwater (FFS), saltwater only (SSS), and freshwater only (FFF), and the second factor is the level of offshoots cultivation, and two levels were used in it for planting palm offshoots, namely the high level (H), as the offshoots were planted at a level higher than the soil surface by 40 cm and the low level (L) or traditional cultivation, and the offshoots were planted at a low level 40 cm from the soil surface. The experiment was carried out using a randomized complete block design (CRBD) with three replications and the number of treatments used in the experiment was 24. The results showed at the end of the experiment that the use of high cultivation level (H) with saltwater and freshwater alternation treatments (FSF, FFS, SSS) and the control treatment (FFF) gave significant results in reducing the values of soil salinity and soil bulk density. These treatments also gave positive and significant results in the vegetative and physiological growth characteristics of date palm offshoots, including increased offshoot height, leaf number, water, and chlorophyll content, and reduced proline leaf content compared to cultivation at the low level (L). The results also showed that the method of alternating saltwater with freshwater caused saline accumulation with a slight and limited deterioration in some heavy soil properties as well as a limited reduction in the offshoots growth compared to the use of freshwater only, but on the other hand, it led to the provision of freshwater in region where that water began to become scarce.

Key words: Bulk density, Growth characteristics, Freshwater, Saltwater, Water scarcity

Cite this article

Abdulrahman Dawood Salih Al-Hamad, Mohammed Abdulameer Hasan Alnajjar and Majid Abdulhameed Ibrahim (2021). The Effect of Alternating Salinity of Irrigation Water and Cultivation Level on some Soil Properties and Growth of Date Palm (*Phoenix dactylifera* L.) Offshoots of Hillawi Cultivar in Clay Soils. *International Journal of Agricultural and Statistical Sciences.* DocID: https://connectjournals.com/03899.2020.17.63

1. Introduction

The date palm (*Phoenix dactylifera* L.) is a monocotyledonous plant that belongs to the Arecaceae family which includes about 235 genera and 4000 species. Dioecious and unisexual plants, meaning male flowers are borne on male trees. As for the female flowers, they are carried on female trees, and are cultivated in central and southern Iraq with multiple female cultivars that may reach more than 600 cultivars [Al-Rawi (1998)]. Until recently, Iraq was considered one of the largest countries in the world in numbers of date palms which reached 32 million palm trees in the 1960s. This national wealth was subjected to

Author for correspondence** ***Received *November 27, 2020* ***Revised*** *February 26, 2021* ***Accepted*** *March 14, 2021*

deterioration due to environmental and natural conditions and war disasters in addition to neglect, lack of care for date palm orchards, scarcity of water and deterioration of its quality [Al-Hamad (2015)]. Many researches and studies have been concerned with the effect of irrigation water quality on the salinization of agricultural lands and its effect on the cultivation, growth and productivity of date palms. Research has indicated that irrigation with water containing a certain amount of salt leads to add salt to soil profiles and changes its physical and chemical properties. Therefore, the importance of soil and water management has emerged and has received the attention of many studies, whether those that dealt with increasing the efficiency of water use by rationalizing its consumption and reducing its waste by adopting the real need for plants, which ensures that the plants are not exposed to water stress and obtain an acceptable economic production, or searching for unconventional water resources such as sewage, groundwater, and drainage water to compensate for the shortage of freshwater [Malash *et al.* (2005)].

Due to the great economic importance of the date palm, it is necessary to work on improving it in terms of quantity and quality, and to promote the cultivation of date palm seedlings using optimal methods of soil and water management and to get rid of the negative effects in them, such as waterlogging, salinization, poor ventilation, fungal diseases, and others [Adnan *et al.* (2009)]. Al-Hamad (2010) mentioned that palm trees lose 10% of the yield when the electrical conductivity value for irrigation water is 4.5 dS m^{-1} and soil is 6.8 dS m^{-1}, and 50% of the yield is lost when the electrical conductivity value for irrigation water is 17.9 dS m^{-1} and for soil is 7.2 dS m^{-1}. In addition to the effect of salinity on the overall physiological processes inside the plant, such as cell division, respiration, photosynthesis, and other processes. Good soil characteristics and quality of irrigation water are important factors to obtain high rates of growth and development of date palm offshoots, especially in areas where weather conditions differ during the seasons of the year. The date palm offshoots grow well in soils with high water retention capacity, low salinity, rich in organic matter, with a good and efficient drainage system [Burbandi (2000)]. Irrigation with low and good quality water will prevent the build-up of salt in the soil. In this regard, some researchers prefer irrigation management in the manner of alternating saltwater with freshwater over the mixing strategy, because mixing water with good quality water and using it in irrigation will reduce the amount of good quality water that is usually used for salt-sensitive crops [Fahd *et al.* (2006)]. Al-Mousawi (2008) showed in his field experiments that the alternating irrigation method can provide a greater chance of success for the uses of saltwater in agriculture with less damage. As this method caused an insignificant accumulation of salts in the soil with a slight and limited deterioration in the physical properties of heavy soils, as well as a limited reduction in crop growth and water consumption, but on the other hand, it led to the provision of a quantity of freshwater. Because of the many problems facing the cultivation of date palm offshoots in heavy soils affected by the salts that have been addressed, and for the purpose of reducing the failure of cultivation and death of offshoots in the early stages of cultivation, and for the purpose of rationing the use of freshwater in the regions of southern Iraq due to water scarcity, this research was conducted.

2. Materials and Methods

The study was conducted in a palm orchard in the Abi Al-Khasib district, 20 km south of Basrah Governorate, for the 2018-2019 agricultural season in clay soil. The primary measurements and analyzes of the orchard soil were carried out by taking soil samples at two depths (0-30) and (30-60) cm and five locations in the orchard randomly. The samples were mixed for each depth separately to obtain a composite sample. Then the composite soil sample was passed through a sieve with 2 mm holes in diameter. Special analyzes were carried out to study the primary physical and chemical properties of the soil. Soil textures were estimated using a pipette method, and bulk density according to Black *et al.* (1965). The electrical conductivity was measured in the extract of saturated soil paste (ECe) according to the method described by Page *et al.*(1982). The pH reaction of soil suspension was measured 1:1 using a pH-meter device, and the organic matter was estimated using the Walkley and Black method which described by Page *et al.* (1982). The positive and negative ions in the saturated soil paste extract, calcium, magnesium, and chlorine were estimated according to the methods described in Page *et al.* (1982). Sodium and potassium were determined using the flame photometer device, and sulfate using the turbidity method as mentioned in Page *et al.* (1982).

Table 1: Some primary physical and chemical properties of site soil.

Properties				Soil depth (cm)	
				0-30	30-60
Sand				104.59	111.44
Silt		$g\ kg^{-1}$		250.01	229.26
Clay				645.40	659.30
Class				Clay	Clay
Bulk density				1.36	1.42
pH				7.63	7.65
Total carbonates $g\ kg^{-1}$				357.2	314.6
Organic matter $g\ kg^{-1}$				3.15	1.04
E.C. $dS\ m^{-1}$				17.14	10.14
Soluble ions	Ca^{++}	$Mmol.L^{-1}$	24.23		
	Mg^{++}		18.27		
	Na^{+}		73.71		
	K^{+}		3.21		
	HCO_3^{-}		1.98		
	SO_4^{-}		36.34		
	Cl^{-1}		99.11		
	CO_3^{-2}		0.00		

Table 1 shows some of the primary physical and chemical properties of the soil of the research site.

2.1 Experiment factors

The research included a study of two factors, namely

Factor A: the alternation factor of saltwater and freshwater with four treatments in a triple cycle, including the treatment of saltwater only (8 $dS\ m^{-1}$) and the control treatment in which freshwater was used only (3.5-4 $dS\ m^{-1}$)

1. Freshwater- Saltwater- Freshwater (FSF)
2. Freshwater- Freshwater- Saltwater (FFS)
3. Saltwater- Saltwater- Saltwater (SSS)
4. Control Freshwater- Freshwater - Freshwater (FFF).

The irrigation with saltwater includes the drainage water of the branch rivers that was diluted with tap water ($dS\ m^{-1}$). The irrigation with freshwater was represented by the use of fresh tap water (0.5-4 $dS\ m^{-1}$).

Factor B: the level of cultivation of date palm offshoots from the soil surface in which two levels were used

1. High level: planting offshoots at a level higher than the soil surface by 40 cm (High)
2. Low level: planting offshoots at a level lower than the soil surface by 40 cm (Low).

The research included the cultivation of 24 offshoots of date palms of the Hillawi cultivar on 3/March/2018, with three replicates for each treatment. The offshoots were treated after separated them with Caravan G insecticide/fungicide. Green cast is a trademark of a Syngenta Group Company at 10% for 10 minutes. The pits used for planting offshoots were dug two weeks before they were excised from the mother plants, and the size of 1.5 m length x 1.5 m width x 1 m deep, and the distance was 8 meters between them. The sand was added when planting low to cover three-quarters of the pit. As for high planting, the soil was added to a height of 40 cm and cement support was made around the shoulder of the basin to prevent soil erosion when irrigation. After completing the requirements for planting, the offshoots were surrounded by palm fronds to protect them from climatic conditions such as cold and high temperatures. Irrigation water was added to the treatments at a rate of 60 liters per three days in the hot months of the year with high evaporation that included April, May, June, July, August, September, and October, and irrigation at a rate of 60 liters every eight days in the cold and little evaporation months that included November, September, January, February, and March.

The measurements of the final experiment included the following:

Soil properties

Soil samples were taken at the end of the experiment for all parameters at 0-30 cm depth to estimate each of the bulk density by the core method described by Black *et al.* (1965), and measuring the electrical conductivity of saturated soil paste extract using an EC meter.

2.2 Characteristics of vegetative and physiological growth, including the following:

The increase in the offshoot height

Date palm offshoot height was measured on the longest frond from the base area to the top with a tape measure and the increase in the offshoot height was calculated according to the following equation:

The increase in offshoot height = the shoot height at the end of the experiment-the shoot height after planting.

The increase in the leaf number

The number of new leaves of offshoot was calculated according to the following equation:

The number of new leaves = the number of the offshoot leaves at the end of the experiment- the number of offshoot leaves after planting.

The increase in the leaf number

The number of new leaves of offshoot was calculated according to the following equation:

The number of new leaves = the number of the offshoot leaves at the end of the experiment- the number of offshoot leaves after planting.

Water content (%) in leaves

A weight of 10 grams of fresh leaflets of the offshoot was dried by a vacuum oven at a temperature of 70°C for a period of 72 hours, and after cooling and weighing it, it was returned again to the convection oven for two hours at the same temperature, then cooled, weighed and measured the water content of the leaves as follows:

Water content (%) = (dry weight-fresh weight)/(fresh weight) × 100

Proline content in leaves

The amino acid proline content in the leaves was estimated according to the method described in Troll and Lindesly (1955) using ethyl alcohol and a spectrophotometer at a wavelength of 520 nm.

The total chlorophyll content in the leaves

Estimate total chlorophyll content in leaves based on the Holden method and described by Howertiz (1975).

2.3 The experimental design and statistical analysis

The experiment was carried out using a randomized complete block design (RCBD) with three replications. Data were analyzed statistically using the Genstat statistical program, version 24 using the ANOVA table. The revised least significant difference (R-LSD) was used to compare the mean of the treatments at a probability level of 5% [Al-Rawi and Khalaf Allah (2000)].

3. Results and Discussion

3.1 The effect of experiment factors on some soil properties

Soil salinity

The results showed a significant effect of experimental factors on salinity values at a probability level of 0.05. The results of the saltwater and freshwater alternation in Table 2 showed that the SSS treatment showed the highest values at an average of 11.79 dS m^{-1}, followed by the FFS treatment at an average of 11.25 dS m^{-1}, then the FSF treatment, which was at an average of 9.63 dS m^{-1}. While the control treatment FFF was recorded the lowest value, at an average of 7.64 dS m^{-1}. As for the effect of the agricultural level factor on soil salinity values, the results indicated in the same table that the low-level cultivation (L) recorded the highest salinity value at an average of 10.71 dS m^{-1}. While at high-level cultivation (H) it reached 9.44 dS m^{-1}, with a significant difference. The interaction between the alternation of saltwater and freshwater and the cultivation level gave a significant effect at the probability level of 0.05. The results in Table 3 showed that the use of high-level cultivation with alternating saltwater and freshwater (FSF, FFS, SSS) gave significant results in reducing soil salinity values compared to cultivation at the low-level L of the soil surface. The interaction treatment SSS and low-level cultivation recorded the highest value that reached 11.98 dS m^{-1} followed by the FFS and low-level interaction treatment at an average of 11.71 dS m^{-1} which did not have a significant difference between it and the SSS and high-level cultivation interaction treatment, which

Table 2: The general average of the salinity and bulk density values of the soil of treatments at the end of the experiment.

Alternation treatment	Soil properties	
	Soil salinity (dS m^{-1})	Bulk density (µg m^{-3})
Control FFF	7.64	1.24
FSF	9.63	1.33
FFS	11.25	1.35
SSS	11.79	1.38
R-LSD 0.05	0.17	0.011
Cultivation level factor		
Low level (L)	10.71	1.34
High level (H)	9.44	1.31
R-LSD 0.05	0.12	0.008

Table 3: The values of the interaction between alternation treatment and cultivation level for the salinity and bulk density of the soil at the end of the experiment.

Alternation treatment	Cultivation level	Soil properties	
		Soil salinity (dS m^{-1})	Bulk density (µg m^{-3})
Control FFF	Low	8.44	1.26
	High	6.85	1.22
FSF	Low	10.73	1.35
	High	8.53	1.31
FFS	Low	11.71	1.37
	High	10.78	1.34
SSS	Low	11.98	1.39
	High	11.60	1.37
R-LSD 0.05		0.24	0.01

was at an average of 11.60 dS m^{-1} and differed significantly with the FFS and high-level interaction treatment, which was at an average of 10.78 dS m^{-1}. It was observed that the control treatment at high-level cultivation recorded the lowest value of soil salinity at an average of 6.85 dS m^{-1}, followed by the same treatment at the low-level cultivation at an average of 8.44 dS m^{-1}, with a significant difference from it. While the rest of the interaction treatments took mean values between the highest and lowest value. The increase in salinity values when treating the SSS is due to the increase in the succession of irrigation with saltwater when using this treatment compared to the rest of the alternation treatments. While the increase in the successive use of freshwater in one cycle significantly reduced the soil salinity. These results were identical to the results found by Mohamed and Al-Delfi (2017) that continuous irrigation with high salinity water leads to an increase in soil salinity and that mixing freshwater with it reduces soil salinity in the irrigation process. The decrease in soil salinity when treating at a high level cultivation is due to increase the washing operations in it to all sides compared to low-level cultivation which soil conditions are close to the field soil conditions and to be more affected by some of the negative effects of agricultural service operations such as compaction of the soil with continuous movement and waterlogging, and the proximity of the cultivation level to the ground water level as well as its direct contact with the original high salinity field soil (Table 1).

Bulk density

The results of the saltwater and freshwater alternation in Table 2 showed that the SSS treatment was the highest in the values of bulk density at an average of 1.38 μg m^{-1}, followed by the FFS treatment at an average of 1.35 μg m^{-1}, then the treatment FSF with an average of 1.33 m^{-1}. While the control treatment FFF recorded the lowest value at an average of 1.24 m^{-1}. As for the level of cultivation factor, the results showed that the treatment at low level cultivation was at an average of 1.34 m^{-1}. While it decreased at high level cultivation to 1.31 m^{-1} with a significant difference between them. As for the values of bulk density in the interaction factors, the results in Table 3 showed that there are significant differences between them. The highest value was with the SSS and low-level interaction treatment at an average of 1.39 m^{-1}, followed by the interaction treatment for the same alternation treatment at high-level cultivation of 1.37 m^{-1} which was equal with the FFS and low-level interaction treatment. The control treatment FFF at high level cultivation recorded the lowest value in bulk density at an average of 1.22 m^{-1}, then the interaction treatment for the same treatment at low level cultivation at an average of 1.26 m^{-1} with a significant difference from it. The high values of bulk density in the treatments in which the alternation of saltwater in one irrigation cycle increased due to the role that salts play in the deterioration of the physical properties of the soil, including the bulk density. These results are consistent with the results found by Mohamed *et al.* (2017) and Al-Hamad (2010), in an increase of the bulk density values when using saltwater in soil irrigation compared to using freshwater and attributing this to the destruction of large aggregations with diameters of 8.4 mm, a decrease in their percentage and an increase in the percentage of small aggregations in the case of soil salinization, which leads to a decrease in the percentage of intra-spaces and their volumes leading to increase the unit mass per unit volume.

3.2 The effect of experimental factors on some growth characteristics of date palm offshoot

Water content

The results indicated in Table 4 that there was a significant effect of the saltwater and freshwater alternation treatments on the values of water content of leaves at the end of the experiment. The control treatment FFF recorded the highest value with a value of 61.06%, followed by the FSF which was 60.32%, and the FFS treatment at 59.38%. While the treatment of alternation SSS recorded the lowest water content in the leaves was 58.02%. As for the effect of the level of cultivation, the results indicated in Table 4 that high cultivation (H) was significantly higher in water content values, which reached 60.00%, while it reached 59.38% at low-level cultivation. The interaction between the two study factors showed a significant effect on the water content values at the end of the experiment (Table 5). The interaction between the alternation treatments of saltwater and freshwater (SSS, FFS, FSF) at high-level cultivation was significantly superior to the values of 60.54%, 60.05% and 58.36%, respectively, compared to the interactions of the same treatments at low-level cultivation which amounted to 60.10%, 58.71% and 57.69%, respectively, with a significant difference. The treatment of control FFF treatment at high and low level cultivation recorded the highest values of water content reaching 61.05% and 61.06% respectively, without a significant difference between them. The decrease in the water content of leaves in the alternation treatments, especially in the treatment of SSS, clearly indicates the injurious effect of salinity in increasing the osmotic pressure in the soil solution and its negative effect on the process of water absorption by the roots and the reduction of the water content inside the plant cells. Mudgal *et al.* (2010) indicated that the effect of salt stress is evident in dry and semi-arid regions and is one of the most important stresses affecting plant growth and production in the world and affects all physiological processes, including the water content of the plant.

Offshoot height

The results in Table 4 showed that the saltwater and freshwater alternation treatments had a significant effect on the height of the offshoots at the end of the experiment. The control treatment FFF was significantly superior to reach 14.16 cm, followed by the FSF alternation treatment, which amounted to 11.93 cm, then the FFS treatment, which reached 8.76 cm. The SSS alternation treatment recorded the lowest value in the average plant height, reaching 7.57 cm, with a significant difference. The table also showed that the planting level factor had a significant effect on the offshoot height values. The high-level cultivation treatment was significantly superior to the low-level cultivation treatment. The values were 11.47 cm and 9.74 cm, respectively. The interactions of the two studied factors showed a significant effect on this characteristic (Table 5). The interaction treatment of the control treatment with the elevated cultivation recorded the highest height of 14.50 cm, followed by the interaction treatment at the low cultivation, which reached 13.82 cm. Whereas, the SSS treatment at low-level cultivation recorded the lowest value in plant height reaching 6.63 cm, followed by the interaction for the same treatment at the high-level cultivation which reached 8.52 cm. The rest of the interaction treatments recorded intermediate values between the highest and lowest mentioned values. It is noted from the results that all the interaction treatments

Table 4: The general average of the values of some vegetative and physiological characteristics at the end of the experiment.

Alternation treatment	Vegetative and physiological characteristics				
	Water content (%)	Proline (µg g^{-1})	Chlorophyll (mg 100g^{-1})	Offshoot height (cm)	Increase in leaf number/offshoot
Control FFF	61.06	19.76	10.61	14.16	4.09
FSF	60.32	20.25	9.98	11.93	3.63
FFS	59.38	20.69	9.65	8.76	3.45
SSS	58.02	21.87	8.74	7.57	2.55
R-LSD 0.05	0.29	0.82	0.029	0.075	0.07
Cultivation level factor					
Low level	59.38	21.00	9.51	9.74	3.19
High level	60.00	20.28	9.98	11.47	3.67
R-LSD 0.05	0.20	0.58	0.014	0.037	0.05

of high-level cultivation and the alternation of saltwater and freshwater, including the control treatment, were significantly superior to the low-level cultivation with the same alternation treatments, with significant differences. This indicates the importance of cultivating date palm offshoots at a level slightly higher than that of field soil with clay texture affected by salts. The results also showed the effect of using the method of alternating saltwater and freshwater in reducing water waste and rationing the use of freshwater, and it gave acceptable results in the average of plant height compared to the use of saltwater only (SSS). These results are consistent with the results obtained by Al-Mayahi (2010) that the use of alternation low-salinity water with water irrigation led to a significant increase in date palm height and other production characteristics compared to the use of high-salinity water (between 5.5-6.0 dS m^{-1}) that gave the lowest values are in plant height.

Total chlorophyll content in leaves

Table 4 showed the effect of alternation of saltwater and freshwater and cultivation level on leaf content of total chlorophyll. The results indicated that the increased alternation of saltwater in one irrigation cycle with the SSS treatment caused a significant decrease in the leaf content of total chlorophyll, which amounted to 8.74 mg 100 g^{-1}, followed by the alternation treatments FSF and FFS, which reached 9.98 and 9.65 mg 100 g^{-1}, respectively. While the control treatment FFF recorded the highest value was 10.61 mg 100 g^{-1}. The effect of the level of cultivation on the total chlorophyll content in the leaves, the results in Table 4 indicated that the high-level cultivation reached the highest value at an average of 9.98 mg 100 g^{-1}, while the low-level cultivation had 9.51 mg 100 g^{-1}, with a significant difference from it. As for the total chlorophyll content when the interaction factors for the alternation of saltwater and freshwater with the cultivation level, the results in Table 5 showed the presence of significant differences. The highest value was recorded when the control treatment at the high-level cultivation was 10.92 mg 100 g^{-1}. The lowest value for the chlorophyll content in the leaves was when the SSS treatment at low-level cultivation amounted to 8.37 mg 100 g^{-1}, with a significant difference from the rest of the interaction treatments. The decrease in the leaf content of total chlorophyll when treating the alternation of saltwater SSS is due to the environmental stress of increasing the salinity of irrigation water, which led to a decrease in the rate of chlorophyll biosynthesis due to the lack of the necessary elements in its construction such as nitrogen and potassium and the increased toxicity of the sodium component in the leaves, in addition to a decrease in absorption of water due to an increase in osmotic pressure, which leads to damage to the photosynthetic reaction centers [Zhang *et al.* (2003)]. Also, an increase in salinity causes an increase in the ROS that can cause damage to chloroplasts due to its negative interaction nature with proteins, DNA, fats, and pigments, and the damage it causes to cells. Also, one of the reasons for the decrease in chlorophyll under stress is the increased activity of the enzyme chlorophyllase, which is responsible for the breakdown of the chlorophyll pigment in the leaves [Ashraf (2009)]. These results are consistent with what was mentioned by Assirey (2015) that exposing the date palm tree to harsh environmental conditions or the so-called stress will affect all its physiological processes, including the

Table 5: The effect of the interaction between alternation treatment and cultivation level on the vegetative and physiological characteristics at the end of the experiment.

Alternation treatment	Cultivation level	Vegetative and physiological characteristics				
		Water content (%)	Proline (µg g^{-1})	Chlorophyll (mg $100g^{-1}$)	Offshoot height (cm)	Increase in leaf number/offshoot
Control FFF	Low	61.05	19.97	10.31	13.82	4.02
	High	61.06	19.54	10.92	14.50	4.17
FSF	Low	60.10	20.38	9.79	10.14	3.43
	High	60.54	20.11	10.18	13.73	3.82
FFS	Low	58.71	21.23	9.59	8.37	3.20
	High	60.05	20.15	9.72	9.14	3.71
SSS	Low	57.69	22.44	8.37	6.63	2.12
	High	58.36	21.30	9.12	8.52	2.99
R-LSD 0.05		0.41	1.17	0.029	0.075	0.10

chlorophyll pigment biosynthesis. The high level of chlorophyll at the high-level cultivation and its interactions with the alternation of saltwater and freshwater treatments is due to the fact that the high level of cultivation has improved the environmental conditions of date palm offshoots, including the improvement of some soil properties such as the decrease in the bulk density and soil salinity Tables 2 and 3.

Proline content in leaves

The results in Table 4 showed that there were significant differences in the effect of the saltwater and freshwater alternation treatments on the leaves content of the amino acid proline. The SSS treatment recorded a significant increase in the leaf content of proline, which amounted to 21.87 μg gm^{-1}, followed by the FFS treatment in which the proline content reached 20.69 gm^{-1}. The control treatment recorded the lowest number in the leaf content of proline, amounting to 19.76 gm^{-1} with a significant difference from the rest of the alternation treatments. As for the effect of cultivation level on the proline content of leaves, the results in the same table showed that the low-level cultivation recorded a significant increase of 21.00 gm^{-1} compared to the high-level cultivation that was 20.28 gm^{-1} Table 5. The SSS at low-level cultivation interaction treatment recorded the highest value at an average of 22.44 gm^{-1}, while the interaction treatment control at high-level cultivation recorded the lowest value, with a significant difference, reaching 19.54 gm^{-1}. The results showed that the interaction of all alternation treatments of saltwater and freshwater at low-level cultivation recorded the highest value in the leaves content of the amino acid proline compared with the same treatments at high-level cultivation, including the control treatment. The increase in the leaves content of the amino acid proline is considered an important indicator in the trees' tolerance of environmental stress conditions as it is one of the amino acids that enter into the biosynthesis of protein and leads to preventing the breakdown of proteins inside plant cells and thus prevents their degradation. Its presence strengthens the bonds between the amino acids that make up the protein, and its accumulation increases when plants are exposed to certain stresses such as water and salt stresses, in addition to being one of the compatible osmolytes that play an important role in the mechanism of osmoregulation, thus increasing the tolerance of trees exposed to unsuitable environmental conditions and their presence is a response. It is an action that the plant takes on whatever stressful reality it is exposed by Yaish (2015). Its accumulation in date palm leaves confirms the role that this amino acid plays in protecting against environmental stresses by modifying the osmotic stress of the plant cell and maintaining the structure of cell membranes. Many researches indicated that there is a positive relationship between the accumulation of proline and the plant's tolerance to stress conditions [Hakim *et al.* (2014) and Yaish (2015)].

The increase in the number of leaves

The results in Table 4 showed that the increased alternation of saltwater led to a decrease in the number of leaves formed, especially when the SSS treatment amounted to 2.55 leaves $offshoot^{-1}$. The number of leaves per shoot increased with the increase in the alternation of freshwater and saltwater in one irrigation cycle with the two treatments FSF and FFS, reaching 3.63 and 3.45 leaves offshoot^{-1}, and the highest value was reached when the control treatment FFF at an average of 4.09 leaves offshoot^{-1}. As for the effect of the level of cultivation on the increase in the number of leaves per offshoot, the results of the same table showed that the high-level cultivation was recorded the highest value at an average of 3.67 leaves offshoot^{-1}. The low-level cultivation was recorded an average of 3.19 leaves offshoot^{-1} with a significant difference. As for the number of leaves when the interaction treatments for the alternation of saltwater and freshwater and the level of cultivation, the results showed in Table 5 the presence of significant differences. The highest value was recorded when the interaction treatment FFF at high-level cultivation, which amounted to 4.17 leaves offshoot^{-1}, followed by the interaction treatment FFF at low-level cultivation, which amounted to 4.02 leaves offshoot^{-1}. The lowest value was recorded at the SSS and low-level cultivation interaction treatment, which was 2.12 leaves offshoot^{-1} with a significant difference from the rest of the other alternation treatments. The decrease in the number of leaves when the saltwater alternation treatments, especially the SSS treatment due to the negative effect of salts on the physiological processes of the plant, the most important of which is the photosynthesis activity, hormonal balance, and increased free radicals that accumulate as a result of exposure to salt stress. Also, increasing the salinity of irrigation water causes an increase in osmotic potential and a decrease in the ability of the plant to absorb water and important nutrients for the plant, and on the other hand, it leads to toxicity with some ions, especially the sodium ion, and the disturbances it causes and affects the vegetative system [Hakim *et al.* (2014)].

4. Conclusion

From the results obtained, we conclude the ability of date palm offshoots to tolerant saltwater irrigation of 8 dS m^{-1} and the importance of cultivating date palm offshoots at a high level slightly than the soil surface that soil was clay textures affected by salts. The results also showed that the effect of using the alternating saltwater and freshwater (FSF, FFS) led to reducing water waste and rationing the use of freshwater, it gave good and acceptable results in the growth characteristics of date palm offshoots compared with using saltwater irrigation (SSS).

References

Adnan, H.S., N.H. Raad, S.A. Basem and A.H. Zaidoun (2009). The effect of different amounts and duration of irrigation on the growth of palm offshoots under the drip and flood irrigation systems. *Iraqi Agriculture Journal,* **14(2)**, 153-162.

Al-Hamad, A.D.S. (2010). The effect of irrigation water quality for the sites of Al-Sedoor and Alathnaab on some productive indicators of two varieties of the date palm (*Phoenix dactylifera* L.), Al-Barhi, and Al-Hillawi cultivars. *Basrah Research Journal (Sciences)*, *36(3)*, 57-65.

Al-Hamad, A.D.S. (2015). The effect of the interval, irrigation parameters, and soil surface covering on some of its characteristics and the production of date palm *(Phoenix dactylifera* L.) *Ph.D. Thesis*, College of Agriculture, University of Basra, Iraq.

Al-Mayahi, H.A. (2010). The effect of dripping drainage and alternation of irrigation water quality on some soil properties and the growth of *Zea mays* L. *M.Sc. Thesis*, College of Agriculture, University of Basra, Iraq.

Al-Mousawi, K.A.H. (2008). The effect of alternating irrigation water quality and soil moisture content on some physical and chemical properties of marsh Al-Hammar soil and water consumption of Maize crop. *Ph.D. Thesis*, College of Agriculture, Basrah University, Iraq.

Al-Rawi, K.M. and A.A. Khalaf Allah (2000). Design and Analysis of Agricultural Experiments. Dar Al-Kutub for Printing and Publishing, College of Agriculture, University of Mosul, Iraq.

Ashraf, M. (2009). Biotechnological approach of improving plant salt tolerance using antioxidants as markers. *Biotechnology Advances*, **27**, 84-93.

Assirey, E.A.R. (2015). Nutritional composition of fruit of 10 date palm (*Phoenix dactylifera* L.) cultivars grown in Saudi Arabia. *Journal of Taibah University for Science*, **9**, 75-79.

Black, C.A., D.D. Evans and J.L. White (1965). Methods of Soil Analysis. Part 1: Physical and Mineralogical Properties, Including Statistics of Measurement and Sampling, Agronomy Monograph 9.1, American Society of Agronomy (ASA). Inc. Publisher, Madison, Wisconsin, USA.

Burbandi, A. (2000). Palm Technologies and Horizons. Arab Center for the Studies of Arid Zones and Lands. Damascus, Syria.

Fahd, A.A., Y.S. Kamal and L.C. Ibrahim (2006). Using saline water for consecutive seasons to irrigate corn and its effects on yield and soil salinity. *Iraqi Journal of Agriculture*, **11(1)**, 1-12.

Hakim, M.A., A.S. Juraimi, M.M. Hanafi, M.R. Ismail, M.Y.

Rafil, F. Aslani and A. Selamat (2014). The effect of salinity on chlorophyll, Proline and mineral nutrients in common weeds of coastal rice fields in Malaysia. *Journal of Environmental Biology*, **35**, 855-864.

Howrtiz, W. (1975). Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D.C., U.S.A.

Malash, N.T., J. Flowers and R. Ragab (2005). Effect of irrigation systems and water management practices using saline and non- saline water on tomato production. *Agricultural Water Management*, **78**, 25-38.

Mohamed, A.A. and H.F.K. Al-Delfi (2017). Role of organic residues in Reducing the effect of water salinity on corn (*Zea mays* L.) *Growth. Assiut J. Agric. Sci.,* **48(5)**, 231-254.

Mudgal, V., N. Madaan and A. Mudgal (2010) Biochemical Mechanisms of Salt Tolerance in Plants: *A Review. Int. J. Bot,* **6**, 136-143.

Page, A.L., K.H. Miller and D.R. Kenney (1982). *Method Analysis*. Part 2nd ed. Agronomy.

Troll, W. and J. Lindsley (1955). A Photometric method for determination of proline. *J. Biol. Chem.*, **215**, 655-661.

Yaish, M.W. (2015). Proline accumulation is a general response to abiotic stress in the date palm tree (*Phoenix dactylifera* L.). *Genetics and Molecular Research*, **14(3)**, 9943-9950.

Zhang, S., J. Weng, J. Pan, T. Tu, S. Yao and C. Xu (2003). Study on the photogeneration of superoxide radicals in Photosystem II with EPR spin trapping techniques. *Photosynth Res.*, **75**, 41-48.