



The effect of operational pressure on the irrigation system with fixed sprinkler and moisture depletion and soil softening on moisture content and salt distribution of clay soil and growth of barley plant (*Hordeum vulgare* L.)

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Abstract.

A field experiment was conducted at the research station of the College of Agriculture / University of Basra at the Karmat Ali site, during the 2020-2021 cropping season in clay soil to study the effect of the operating pressure of the fixed sprinkler irrigation system, moisture depletion and the degree of soil softening on the moisture content, salt distribution of the soil and crop growth Barley (*Hordeum Vulgare* L.). Experiment coefficients, which include three main factors, were distributed in the Amelia experiment. The factors were the operating pressure factor, which includes three pressures, 150 kPa (P_1), 250 kPa (P_2) and 350 kPa (P_3), and the moisture depletion factor, which includes the depletion at 75% of ready water (M_1) and depletion at 50% of ready water (M_2), and the third factor is the soil softening factor by disc harrows, and it includes softening the soil after plowing once (C) and softening the soil three times (S). The experiment's parameters were distributed in three replications, using a randomized complete block design (R.C.B.D) for three replicates. The experimental units were planted with barley crop, where irrigation is carried out according to the moisture depletion of the ready water of the soil, in addition to the requirements for washing 20%. Soil samples were taken at the middle and end of the growing season, and for soil depths, which are three depths: (0-15) cm (d_1), (15-30) cm (d_2) and (30-45) cm (d_3). The results showed that the increase in the operating pressure from P_1 to P_2 and then P_3 result to an increase in the moisture content and a decrease in the salt distribution of the soil. One whet (C) on the soil softening treatment three whet (S) in increasing the moisture content and decreasing the salt distribution of the soil at the middle and end of the growing season.

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Keywords: Irrigation with fixed sprinkler, moisture depletion, degree of soil softening, moisture content, salt distribution.

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Introduction.

Water is one of the important natural resources that play a fundamental role in human, animal and plant life, and it is the main determinant of agricultural production, especially in arid and semi-arid areas, including Iraq, which depends mainly on irrigated agriculture. In view of the drought conditions experienced by the region in general and Iraq in particular, as well as the low discharge of the Tigris and Euphrates rivers, attention has turned to the use of modern irrigation technologies, including sprinkler irrigation methods, which have a high water conveyance efficiency. The efficiency of water use by sprinkler irrigation is about 70%, while it reaches in Surface irrigation 50-60% in the best conditions and the losses are more than 40% (Al-Kubaisi, 2001). The main motive for the use of modern technologies in irrigation is the need to increase food production. Inability to choose an appropriate irrigation method exposes the construction of the soil to deterioration and deterioration of some of its physical properties, such as soil crusting, low aggregate stability, water content, water movement in it, total porosity, increase in its bulk density and other physical characteristics (Jassim *et al.*, 2009). The effect of the fixed sprinkler irrigation system and sprinkler irrigation on the distribution of moisture content and electrical conductivity of the soil, As the percentage increase in the moisture content of the sprinkler irrigation system compared to the sprinkler irrigation system is 20% for a depth of (0-30) cm, The electrical conductivity value decreased with increasing soil depth during the post-harvest period, Decrease in the value of the electrical conductivity of the soil for the 2015 spring agricultural season, after harvest and under the sprinkler irrigation system, where the electrical conductivity values were (0.28, 0.25 and 0.25) dSm^{-1} for soil depths (0-10) cm and (10-20) cm and (20- 30) cm, respectively (Chen *et al.*, 2019). Deficient irrigation is one of the processes of using less water than required for optimal plant growth and has many advantages,

including reducing water consumption, improving plant response to water deficit, and increasing crop water productivity (Li *et al.*, 2019). The values of soil moisture content reached (34.31, 37.24 and 37.66)% for the above three discharges, respectively, and the soil salinity decreased at depth (0-20) cm and amounted to (0.95, 0.81 and 0.83) dS m^{-1} for the above three expenditures, respectively. The use of soil softening equipment after the plowing process is a primary objective of fraction, fraction and softening large soil aggregates and providing a suitable bed for the seed bed as well as burying crop and bush residues, which helps in creating suitable conditions for seed germination. Therefore, attention should be paid to the smoothing process, by choosing the appropriate machine, the speed of the front puller, and the number of smoothing times. The smoothing process has an effective role in improving the physical and water properties of the soil, in addition to affecting the horizontal and vertical movement of water in the soil body (Jassim and Saadoun, 2016).

In order to address the problem of water scarcity, reduce irrigation water loss and maintain a good soil structure, and for the loss of studies of sprinkler irrigation in the southern region of Iraq, this study was conducted and its most important objectives are, the effect of the interaction between operational pressure, moisture depletion and soil softening on some physical properties of soil and salinity distribution in Clay soil.

Materials and working methods

A field experiment was conducted at the research station of the College of Agriculture - University of Basra in Karmat Ali site in Basrah governorate for growing barley (*Hordeum vulgare* L.) during the growing season 2020-2021 in clayey soil categorized as Clayey mixed, calcareous hyperthermic typic torrifuvent (Al-Atab, 2008) The results in Table (1) show some physical and chemical properties of the soil of the study area that were estimated according to the methods described in (Black *et al.*, 1965) and (Page *et al.*, 1982).



The factors of the study included the following:

1. The operating pressure factor has three parameters: 150 kPa (P_1), 250 kPa (P_2) and 350 kPa (P_3). The operating pressure of the fixed sprinkler irrigation system was determined by pressure gauges and Globe valves connected to each sprinkler and at the connection to the main pipe with the pump.
2. Use the moisture depletion treatment with two treatments which are depletion at 75% of the ready water (M_1) and depletion at 50% of the ready water (M_2).
3. The degree of soil softening is factored by two treatments, namely, softening the soil by means of the disc harrows, and it includes softening the soil after plowing once (C) and softening the soil three times (S).

The experiment was implemented using a randomized complete block design (R.C.B.D) with three replications. The experimental land was divided into three replicates, then the experimental land was divided into 36 experimental units between one experimental unit and another 1 m, and each experimental unit contained one sprinkler. treatment S), and the remaining 18 experimental units were left softened once (coarse soil C treatment). After completing the preparation of the field, the field was planted with barley seeds of a local variety on 1/12/2020. The experiment field was irrigated by fixed sprinkler irrigation with a quantity of water equal to 100% of the value of the field capacity, with the addition of 20% of the irrigation water as washing requirements.

Table (1) Some initial physical, mechanical and chemical properties of soil, depths (0-15), (15-30), (30-45) cm, and salinity of irrigation water during plant growth stages

soil depth cm			Units	Properties
(30-45)	(15-30)	(0-15)		
123.453	137.324	172.657	g kg ⁻¹	Sand
327.026	317.746	316.513		Silt
549.521	544.930	510.830		Clay
Clay	Clay	Clay	—	Texture
2.623	2.623	2.621	Mg m ⁻³	Particle density
1.343	1.321	1.299	Mg m ⁻³	Bulk density
48.799	49.637	50.438	%	Total porosity
53.320	56.500	54.230	%	Moisture when saturated
33.569	34.985	32.876	%	Field capacity
1.810	3.260	5.935	g kg ⁻¹	Organic matter
293.365	310.29	326.815	g kg ⁻¹	Total carbonate
28.410	29.105	28.355	Cmol kg ⁻¹	CEC
29.255	29.170	25.130	mmol ⁻¹	Ca ⁺⁺
21.520	23.130	21.715	mmol ⁻¹	Mg ⁺⁺
1.575	1.745	1.340	mmol ⁻¹	K ⁺
70.050	67.175	60.010	mmol ⁻¹	Na ⁺
0.00	0.00	0.00	mmol ⁻¹	CO ₃ ⁻⁻
1.095	1.225	1.340	mmol ⁻¹	HCO ₃ ⁻
154.030	135.425	109.675	mmol ⁻¹	Cl ⁻
22.753	19.691	17.913	mmol ⁻¹	SO ₄ ⁻⁻
20.155	18.720	18.670	dS m ⁻¹	EC _e



7.654	7.450	7.470	———	pH
		1.25	m	Ground water
The end of the growing season	middle of the growing season	Beginning of the growing season	dS m ⁻¹	Irrigation water salinity
5.25	5.13	5.13		

The amount of irrigation water to be added was calculated until the seeds were germinated, then the field was irrigated according to the soil moisture depletion factor, and after (134) days from the date of planting, the harvest was completed on 12/4/2021. Irrigation water was added to each experimental unit when its moisture content reached 75 and 50% of the

$$W = A \times \frac{\rho b}{\rho w} \times \left\{ \left(\frac{p w f . c}{100} - \frac{p w w . p}{100} \right) \times \text{moisture depletion} \right\} \times D \dots (1)$$

Where is:

W: the volume of water to be added to the experimental unit (m³). **A:** The area of the experimental unit (m²). **Pwf.c:** moisture content at field amplitude (w/w). **Pww.p:** soil moisture content at permanent wilting point (w/w). **pb:** the bulk density of the soil (mgm³). **pw:** the

total ready water, as random samples are taken from the experimental units to monitor the decrease in moisture content gradually after irrigation, and soil samples are taken before each irrigation so that water is added to restore The moisture content of the soil to the limits of field capacity by applying the mathematical equation referred to in (USAID-Inma, 2012):-

density of water (mgm³). **D:** The depth of the soil to be moistened is 30 cm.

The time required to operate the sprinkler irrigation system for each experimental unit was calculated using the following equation (Hajem and Yassin, 1992):

$$T = \frac{W}{Q} \dots (2)$$

Where is:

T: watering time (hours). **W:** volume of water added to the experimental unit (liters). **Q:** Sprinkler drainage (liters hour⁻¹).

Soil moisture and salinity were measured one month after germination and at the end of the growing season (after harvest). According to the methods mentioned above, the salt distribution was measured laboratory by dilution method (1:1). The data was statistically analyzed using the statistical program Genstat DE10.3 for the year 2010 to analyze the variance between the treatments, their interactions and their differences, and the F-test and the value of the least significant difference, the RLSD average at the 0.05 level, were used to compare the means (Al-Mashhadani and Al-Qassab, 2017).

Results and discussion.

1. Moisture content

The results shown in Fig. (1) show a significant effect of the operating pressure factor in the values of soil moisture content at the middle (A) and the end of the growing season (B). The increase in operating pressure result to a significant increase in soil moisture content, and significant differences appeared between pressures P₁, P₂ and P₃, and the highest values of moisture content were 28.476 and 29.376% at operating pressure 350 kPa (P₃) during the middle of the growing season and the end of the growing season, respectively. The reason for this is that the increase in the discharge rate of the sprinkler when the operating pressure was increased to 350 kPa led to an increase in the homogeneity coefficient and this in turn led to an increase in the moisture content in the soil



(Sehsah *et al.*, 2014). The moisture content also decreased with the decrease in the operating pressure, and the values of the moisture content when treating the operating pressure P1 reached (27.428 and 28,328)% at the middle and end of the growing season, respectively. Also, it appears from Fig.(1) show a significant effect of the moisture depletion factor in the values of soil moisture content at the middle (A) and the end of the growing season (B). a significant superiority of M₁ treatment compared to M₂ treatment at the middle and end of the growing season, and their values reached 29.936 and 25.893% at the middle of the season and 30.741 and 26.888% at the end of the season, respectively. To treat the moisture depletion M1 to the amount of water used in irrigation and the close irrigation periods, which led to an increase in the proportion of small and medium pores filled with water, as well as the thickness of the water membranes and keeping the soil water (Li *et al.*, 2019). It is also from Fig. (1) show that there is a

significant effect of the degree of soil softening factor in the values of soil moisture content at the middle (A) and the end of the growing season (B). the effect of the degree of soil softening by disc harrows on the soil moisture content in the middle and end of the growing season, where the C softening treatment once recorded the highest value of moisture content at the middle and end of the growing season, reaching 28.211 and 29.111%, respectively, while the content decreased The moisture content of treatment S softened three times, and the values of moisture content were 27.618 and 29.518%, respectively, The reason for the increase in the values of the moisture content of treatment C is due to the increase in the proportion of large pores of the soil and the improvement of soil construction, which can retain a large amount of water and facilitate the movement of water within the soil sector, as well as the decrease in the rates of soil water loss by surface evaporation due to the capillary rise of water (Al-Mohammadi *et al.*, 2014).

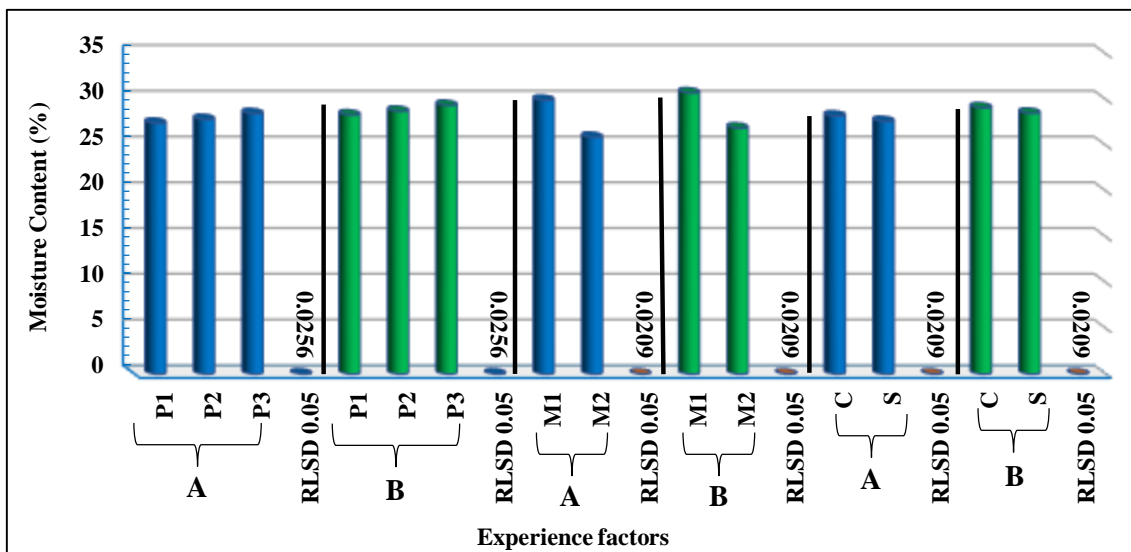


Fig. (1) The effect of operating pressure, moisture depletion and the degree of soil softening on the values of soil moisture content (%) at the middle (A) and end (B) of the growing season



The results in Table (2) show that there is a significant effect of the interaction between the factors of operating pressure and moisture depletion in the values of soil moisture content at the middle (A) and end (B) of the growing season. The table shows that the increase in soil moisture content by increasing the operating pressure from P₁ and then P₂ to P₃ varies according to the difference in the treatment of moisture depletion M₁ and M₂, the highest

differences appeared in the two treatments P₁M₁ and P₁M₂ and the lowest between P₃M₁ and P₃M₂ due to the increase in the operational pressure in Reducing the deterioration of soil structure and increasing the infiltration, as well as reducing surface evaporation, due to reducing the desquamation of the soil surface, which reduced water loss by surface evaporation or through cracks from the soil surface (Al-Mousawi and AbdelKarem, 2016).

Table (2) The effect of the dual interaction of the operating pressure factor, moisture depletion on the values of soil moisture content (%) at the middle (A) and end (B) of the growing season

Moisture depletion \ Operating Pressure	A		B	
	M ₁	M ₂	M ₁	M ₂
P ₁	29.551	25.304	30.356	26.299
P ₂	29.857	25.822	30.662	26.817
P ₃	30.400	26.552	31.205	27.547
RLSD0.05	0.0362		0.0362	

Also, Table (3) shows a significant effect of the interaction between the factors of operating pressure and the degree of soil softening in the values of soil moisture content at the middle (A) and end (B) of the growing season. The variation in the moisture content by increasing the operational pressure from P₁ and then P₂ to P₃ varies according to the difference in the degree of softening, as it showed the highest variations in the moisture content at the two treatments P₃C and P₂C compared with its counterpart

treatments P₃S and P₂S. This is due to the role of increasing the operational pressure in maintaining soil construction Increasing its infiltration, reducing capillary water movement and losing moisture by evaporation, as well as treating the degree of softening that led to the aforementioned reasons in increasing moisture conservation by increasing the infiltration and reducing surface evaporation (Attafya *et al.*, 2017).

Table (3) The effect of the dual interaction of the operating pressure factor and the degree of soil softening on the values of soil moisture content (%) at the middle (A) and end (B) of the growing season

degree of soil softening \ Operating Pressure	A		B	
	C	S	C	S
P ₁	27.675	27.180	28.575	28.080
P ₂	28.180	27.499	29.080	28.399
P ₃	28.777	28.174	29.677	29.074
RLSD0.05	0.0362		0.0362	



The results in Table (4) show that there is a significant effect of the interaction between the two factors of moisture depletion and the degree of soil softening in the values of soil moisture content at the middle (A) and end (B) of the growing season. And (C) treatment, which recorded the highest values of moisture content 30.157 and 30.962% at the middle and end of the growing season, respectively, while the M₂ S treatment recorded the lowest value of moisture content, amounting to 25.521 and 26.516% at the middle and end of the growing season, respectively, and the reason for the

decrease was due to that Because of the increase in the degree of softening of the soil, which caused the movement of small soil particles with the irrigation water and their descent into the large pores, causing the formation of a compact and impermeable layer. And this negative effect is reinforced when the moisture content of the soil surface decreases during the process of falling irrigation water droplets, in which the soil absorption of water droplets is low when treatment M₂ compared to M₁ (Ahmed *et al.*, 2018).

Table (4) The effect of a dual interaction of the moisture depletion factor and the degree of soil softening on the values of soil moisture content (%) at the middle (A) and end (B) of the growing season

Moisture depletion \ degree of soil softening	A		B	
	C	S	C	S
M ₁	30.157	29.715	30.962	30.520
M ₂	26.264	25.521	27.259	26.516
RLSD0.05	0.0295		0.0295	

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The results shown in Table (5) indicate that there are significant effects of the three interaction between the factors of operating pressure, moisture depletion and the degree of soil softening in the values of soil moisture content at the middle (A) and end (B) of the growing season. It is noticeable that the values of moisture content increased with the increase in operational pressure and moisture depletion at a moisture level of 75% of the ready water and when smoothing the soil once, as the treatment P₃M₁C recorded the highest value and reached 30.675 and 31.480% at the middle and end of the growing season, respectively, while the treatment P₁M₂S recorded the lowest The value amounted to 24.973 and 25.968% at the middle and end of the growing season, respectively, due to the divergence of irrigation

periods at moisture depletion at the level of irrigation of 50% of the ready water (M₂), which causes cracking of the soil and the repetition of softening times (S), which leads to soil compaction and high Its apparent density and a decrease in the total porosity of the soil. In general, the values of moisture content increased at the end of the growing season, but it was noted that the treatment P₃M₂C was superior by recording a high value compared to its counterparts at the same moisture depletion, and the value reached 26.879 and 27.874% at the middle and end of the growing season, respectively, and this indicates The increase in the operating pressure with the treatment of softening the soil once reduced the effect of moisture depletion on the soil (Al-Mohammadi, 2013).



Table (5) The effect of the three overlap of the operating pressure factor, moisture depletion and the degree of soil softening on the values of soil moisture content (%) at the middle (A) and end (B) of the growing season

Operating pressure	degree of soil softening Moisture depletion	A		B	
		C	S	C	S
P ₁	M ₁	29.714	29.387	30.519	30.192
	M ₂	25.636	24.973	26.631	25.968
P ₂	M ₁	30.082	29.632	30.887	30.437
	M ₂	26.277	25.366	27.272	26.361
P ₃	M ₁	30.675	30.125	31.480	30.930
	M ₂	26.879	26.224	27.874	27.219
RLSD0.05		0.0511		0.0511	

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2. Soil Salt distribution

The results in Fig.(2) show that there is a significant effect of the operating pressure factor on the electrical conductivity values of the soil at the middle (A) and end (B) of the growing season. It is clear that there is a significant decrease in the electrical conductivity values with the increase in the operating pressure to 350 kilopascals (P₃) compared with the operating pressures (P₁ and P₂). 172%, respectively, at the end of the growing season, and the reason for this is due to an increase in the coefficient of homogeneity, which increases with increasing operational pressure and a decrease in the weighted diameter of the drops, which reduced the collision energy of irrigation water droplets with the soil surface, which reduced the negative impact on soil construction and thus increased the water tip and moisture content of the soil, which increased the efficiency of salt washing to the depths (Sehsah *et al.*, 2014).

Fig.(2) shows that there is a significant effect of the moisture depletion factor on the electrical conductivity values of the soil at the middle (A) and end (B) of the growing season. It is noted that the electrical conductivity values decreased when the moisture depletion was treated by 25% (M₁), with a decrease of 17.400 and 31.458% compared to the 50% treatment (M₂) at the middle and end of the growing season, respectively. M₁, which helped to keep the soil moist and fill most of the soil pores with water,

which increased the process of dissolving and washing salts and their movement vertically, and the reason for the high electrical conductivity values of the soil when treatment M₂ is due to the spacing of irrigation periods and the low moisture content in the soil, which led to a decrease in the efficiency of salt washing (Chu *et al.*,2020).

It is noticed from Fig.(2) that there is a significant effect of the degree of soil softening factor on the electrical conductivity values of the soil at the middle (A) and end (B) of the growing season. It was found that the electrical conductivity values of the soil decreased significantly with the decrease in the degree of soil softening. The soil smoothing treatment once (C) recorded the lowest electrical conductivity values of the soil compared with the soil smoothing treatment three times (S). The percentage of decrease in the electrical conductivity values was 12.913 and 6.583% at The middle and end of the growing season, respectively, and the reason for the decrease in the electrical conductivity values of the soil when treatment (C) compared to treatment (S) is attributed to the increase in the large pore spaces at the expense of small pores and the increase in water permeability and movement within the soil assemblies, leading to a decrease in the speed of the rise of water and salts to the top, which It reduced the salinization process due to water reaching the surface of the soil and evaporating it, which increased the efficiency of



salt washing and pushed it away from the root

system area (Attafya *et al.*, 2017).

Fig.(2) The effect of operating pressure, moisture depletion and the degree of soil softening on the electrical conductivity values of soil (dSm^{-1}) at the middle (A) and end (B) of the growing season

Table (6) shows a significant effect of the dual interaction between the two factors of operating pressure and moisture depletion on the electrical conductivity values of the soil at the middle (A) and end (B) of the growing season. A significant decrease in soil salinity was observed with an increase in sprinkler discharge from 150-350 kPa that varies significantly according to the variance in moisture depletion, and the highest differences between the operational pressure coefficients were in the M_1 moisture depletion treatment compared to its counterparts in the M_2 treatment, and this is due to the aforementioned reasons related to the frequency of irrigation operations. And to

the increase of the moisture content when treating the moisture depletion M_1 compared to the treatment of M_2 , and this reinforced the positive effect of increasing the operational pressure in increasing the efficiency of salt washing for the aforementioned reasons related to maintaining soil construction, which increased the moisture content and the movement of water to the depths, where the treatment P_3M_1 recorded less The value was 9.819 and 7.031 dSm^{-1} at the middle and end of the growing season, respectively, while the highest value was at the treatment P_1M_2 12.729 and 11.148 dSm^{-1} at the middle and end of the growing season, respectively(Chu *et al.*,2020).

Table (6) Effect of the dual interaction of operating pressure and moisture depletion factor on the electrical conductivity values of soil (dSm^{-1}) at the middle (A) and end (B) of the growing season

Moisture depletion \ Operating Pressure	A		B	
	M_1	M_2	M_1	M_2
P_1	10.685	12.729	7.726	11.148
P_2	10.283	12.507	7.323	10.951
P_3	9.819	12.040	7.031	10.115
RLSD0.05	0.042		0.0047	

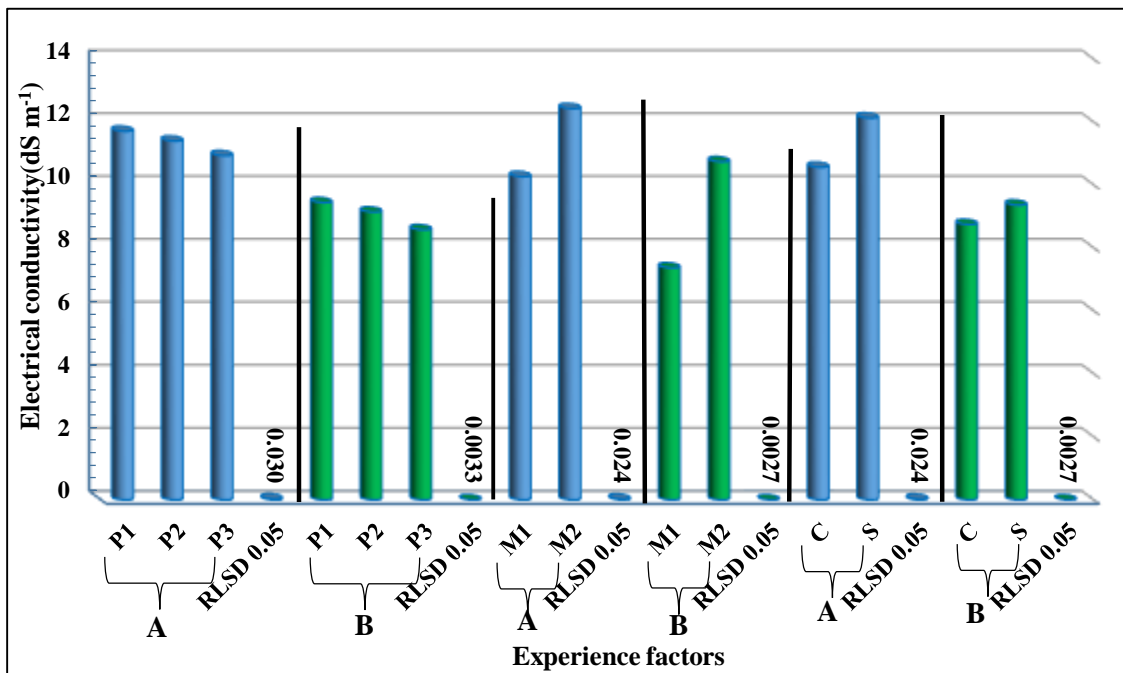
The show from the results in Table (7) that there is a significant effect of the dual interaction between the two factors of operating pressure and the degree of soil softening in the electrical conductivity values of the soil at the middle (A) and the end (B) of the growing season. The variation in the degrees of soil softening C and S in the electrical conductivity values varies according to the difference in the operating pressure, and the highest discrepancies

between C and S were recorded at P_1 and decrease with the increase in the operating pressure to P_2 and P_3 , and this is due to the increase in the operating pressure, which reduces the negative impact of power Precipitation of spray droplets in soil agglomerations, which increased soil moisture and soil infiltration, and decrease surface evaporation (Elmetwalli *et al.*, 2014).



Table (7) The effect of operating pressure and the degree of soil softening on the electrical conductivity values of soil (dSm^{-1}) at the middle (A) and end (B) of the growing season

degree of soil softening \ Operating Pressure	A		B	
	C	S	C	S
P ₁	10.841	12.573	9.127	9.702
P ₂	10.632	12.159	8.895	9.379
P ₃	10.210	11.649	8.155	8.991
RLSD0.05	0.042		0.0047	



The results of Table (8) indicate a significant effect of the dual interaction between the two factors of moisture depletion and the degree of soil softening on the electrical conductivity values of the soil at the middle (A) and end (B) of the growing season. It is noted that the electrical conductivity of the soil decreased with different degrees of soil softening and this varies according to the difference in the moisture depletion factor, as it is noted that the M₁C treatment recorded the lowest value of

9.741 and 6.508% at the middle and end of the growing season, respectively, for the aforementioned reasons, namely, the increase in irrigation periods and the high moisture content For the soil, which increased the efficiency of salt washing, in addition to the one-time softened soil with a large loose surface capacity and a high total porosity, compared with the M₂S treatment, which recorded the highest value of 13.469 and 10.981 dSm^{-1} at the middle and end of the growing season,



respectively, due to the spacing of Irrigation periods, an increase in soil cracks, an increase in evaporation effort from the soil surface, in addition to the degree of soil softening, which

led to soil compaction, which caused a decrease in the moisture content of the soil and the loss of sufficient irrigation water to wash the salts from the soil body (Al-Mohammadi, 2013).

Table (8) Effect of the dual interaction of moisture depletion factor and the degree of soil softening on the electrical conductivity values of soil (dSm⁻¹) at the middle (A) and end (B) of the growing season

Moisture depletion \ degree of soil softening	A		B	
	C	S	C	S
M ₁	9.741	10.785	6.508	7.733
M ₂	11.382	13.469	10.495	10.981

RLSD0.05	0.034	0.0039
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The results in Table (9) indicate a highly significant effect of the three interaction between the operating pressure, moisture depletion and the degree of soil softening on the electrical conductivity values at the middle (A) and end (B) of the growing season. It was found that the lowest value of the electrical conductivity when treating P₃M₁C was 9.397 and 6.723 dSm⁻¹, respectively., at the middle and end of the growing season, while the highest value of the electrical conductivity of

the soil was recorded at the treatment P₁M₂S 13.785 and 11.257 dSm⁻¹, respectively, at the middle and end of the growing season. It is noted from the above-mentioned table that the electrical conductivity values decrease with the increase in the operating pressure and the degree of soil softening C at the moisture depletion M₂, and this indicates that the increase in pressure with softening the soil once reduced the effect of moisture depletion due to the large size of the loose area of the soil.

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Table (9): The effect of the operating pressure factor, moisture depletion and the degree of soil softening on the electrical conductivity values of the soil (dSm⁻¹) at the middle (A) and end (B) of the growing season

Operating pressure	Moisture depletion \ degree of soil softening	A		B	
		C	S	C	S
P ₁	M ₁	10.010	11.361	7.306	8.146
	M ₂	11.673	13.785	11.039	11.257
P ₂	M ₁	9.814	10.752	6.933	7.712
	M ₂	11.449	13.565	10.857	11.046
P ₃	M ₁	9.397	10.241	6.723	7.340
	M ₂	11.023	13.057	9.588	10.641
RLSD0.05		0.060		0.060	

References:

Ahmed, Asmaa Abdullah, Qassem Badr Al-Yasiri and Akram Abdel-Daem Ahmed (2018). Effect of front tractor speed and frequency of smoothing on some physical properties of soil and emergence rates of some crops. Dhi Qar University Journal of Agricultural Research, 7(1): 65-53.

Al-Atab, Salah Mahdi Sultan (2008). Variation in soil properties and its classification for some areas of Basra Governorate. PhD thesis, College of Agriculture - University of Basra.

Al-Kubaisi, Ahmed Madlool (2001). Sprinkler irrigation. Iraqi Journal of Agricultural Sciences, Ministry of Agriculture, pp. 7-12.



Al-Mashhadani, Kamal Alwan Khalaf and Osama Muhammad Jassim Al-Qassab (2017). Common designs and analysis of their experiments with Genstat software. first edition. Baghdad University.

Al-Mohammadi, Shukr Mahmoud (2013). Effect of tillage depth and soil softening on some of its physical properties and growth of potato yield. Anbar Journal of Agricultural Sciences, 11(2): 241-252.

Al-Mohammadi, Shukr Mahmoud, Abdul-Wahhab Khudair Al-Obaid and Saad Inad Al-Dulaimi (2014). Effect of moisture depletion levels on some physical properties of soil, growth and yield of tomato in plowed and uncultivated soils. Anbar Journal of Agricultural Sciences. Research of the fourth scientific conference. Volume 12.

Al-Moussawi, Kawthar Aziz Hamid and Bahaa A.J. Abdulkarem (2016). Study of the effect of the normal and developed subsurface plow and the depth of plowing on the moisture content of clay soil during the growth stages of the sunflower crop (*Helianthus annuus* L.). Wasit Journal of Science and Medicine, 38:3-50.

Attafy, T.M.; W.F. El Metwally and A.M. Okasha(2017). Effect of sprinkler irrigation and land preparation systems on soybean crop production in clayey soil. Misr.J.Ag.Eng.,34(1):157– 180.

Black, C.A.; D.D.Evans; L.L.White; L.E.Ensminger and F.E.Clark (1965). Methods of soil analysis, Am. Soc. Of Agronomy No.9 part I and II .

Chen, Zijing; Yingyan Han; Kang Ning; Chen Luo; Wei Sheng; Shenglin Wang; Shuangxi Fan; Yanfang Wang and Qian Wang (2019). Assessing the performance of different irrigation systems on lettuce (*Lactuca sativa* L.) in the greenhouse.PLOS ONE <https://doi.org/10.1371/journal.pone.0209329> February 4, 2019.

Chu, Lin-lin; Yao-hu Kang and Shu-qin Wan (2020). Effects of water application intensity of micro-sprinkler irrigation and soil salinity on environment of coastal saline soils. Water Science and Engineering.

Elmetwalli, Adel H.; A. Derbala and Waleed Darwisch(2014). Performance Evaluation of Soild –Set sprinkler irrigation under different pressure and nozzle diameters . Misr. J. Ag. Eng.,31(1):195 – 206.

Hajim, Ahmed Youssef and Haqi Ismail Yassin (1992). Field irrigation systems engineering. Ministry of Higher Education and Scientific Research, University of Mosul, Dar al-Kutub for Printing and Publishing.

Jassim, Abdul Razzaq Abdul Latif and Salam Fawaz Saadoun (2016). The effect of some soil preparation systems on the appearance of tillage and some technical indicators of the machine unit. Iraqi Journal of Agricultural Sciences 47(5):1201-1196.

Jassim, Abdul Razzaq Abdul Latif, Kamal Mohsen Al-Qazzaz and Mowaffaq Saeed Naoum (2009). Effect of some sprinkler and surface irrigation systems on some physical properties of soil and maize production. Misr. Soc. Eng. : 286-307.

Li, Y.; Fan H.; Su J.; Fei C.; Wang K.; Tian X. and Ma F.(2019). Regulated deficit irrigation at special development stages increases sugar beet yield.Agron. J. 111, 1293–1303.

page, A.L.; R.H. Miller and D.R. Keeney(1982). Methods of soil analysis , part (2) , 2nd ed . Agronomy g-Wisconsin, Madison.Amer. Soc. Agron. Inc. Publisher.

Sehsah, E.M.E; M.M El Baily and M. Aiad (2014).EVALUATION OF A SINGLE SPRINKLER UNDER EGYPTIAN MICROCLIMATE CONDITIONS. Misr J. Ag. Eng.,31(3): 837 – 854.

USAID-Inma(2012). Irrigation Guidelines. United States Agency for International Development. 1300 Pennsylvania Avenue, NW, Washington DC 20523.

