

EFFECT OF IRRIGATION WATER SALINITY AND TILLAGE SYSTEMS ON SOME PHYSICAL SOIL PROPERTIES

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ABSTRACT

The current study investigated the effect of water quality (the salinity of the irrigation water) and Tillage system on some soil physical properties. The experiment was carried out using RCBD with three replicates. wheat was irrigated by three water sources, a river ,drange and well waters with electrical conductivities 1.3, 3.5 and 6.9 ds.m⁻¹ respectively and three tillage systems were zero tillage (ZT), conventional tillage (CT) and deep tillage (DT). After harvest, some soil physical properties were evaluated including: bulk density, porosity, penetration resistance, hydraulic conductivity and mean weight diameter. The result showed that the bulk density values were 1.40, 1.44 and 1.47 mg.m⁻³ for river, derange and well water. while the porosity values were 47.3%, 45.8% and 43.8%. for river, derange and well water. while the hydraulic conductivity were 5.13, 4.26 and 4.36 cm.h⁻¹for river , derange and well water. also the result showed that the bulk density values were 1.48, 1.44 and 1.38 mg.m⁻³ for ZT, CT and DT respectively. while the porosity values were 44.3, 45.7 and 47.8% for ZT, CT and DT respectively. But for the interactions for electrical conductivity with tillage The result showed that the bulk density values were 1.50 mg.m⁻³ for well water with ZT but decrees value it become 1.34 mg.m⁻³ for river water with DT. The best type of tillage was conventional tillage as it has the ability to improve properties of soil as well as it helps to reduce.

Key words: bulk density, porosity, zero tillage, conventional tillage, well water, drainage water

حسن وآخرون

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تأثير ملوحة مياه الري ونظم الحراثة في بعض صفات التربة الفيزيائية

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المستخلص

تهدف الدراسة الحالية الى بيان مدى تاثير نوعية المياه (ملوحة مياه الري) ونظم الحراثة على بعض الصفات الفيزيائية للتربة. تم تنفيذ التجربة باستخدام تصميم RCBD وبثلاث مكررات . تم ري الحنطة بثلاث مصادر مياه (نهر، بزل ومياه بئر ذات ايصالية كهربائية 1.3 و 3.5 و 6.9 ديسيمنز.م⁻¹ على التوالي كما تم استخدام ثلاث نظم حراثة هي بدون حراثة وحراثة تقليدية وحراثة عميقة . بعد حصد قدرت بعض صفات الفيزيائية للتربة وتضمنت: الكثافة الظاهرية، المسامية، مقاومة التربة للاختراق ،معدل القطر الموزون والايصالية المائية بينت النتائج بان الكثافة الظاهرية كانت قيمها 1.40، 1.44 و 1.47 ميكاغرام.م⁻¹ لمياه النهر ،البزل والبئر على التوالي ،في حين بلغت قيم المسامية 47.3، 45.8 و 43.8% لمياه النهر، البزل والبئر على التوالي كما بلغت قيم الايصالية المائية 5.13، 4.26 و 4.36 سم.ساعة⁻¹ لمياه النهر، البزل والبئر على التوالي. ايضا بينت النتائج بالنسبة لتاثير الحراثة بان قيم الكثافة الظاهرية كانت 1.48، 1.44 و 1.38 لمعاملات بدون حراثة والتقليدية والعميقة على التوالي كما تاثيرت قيم المسامية اذ بلغت 44.3، 45.7 و 47.8% لمعاملات بدون حراثة والتقليدية والعميقة على التوالي. بينما التداخل بين الايصالية الكهربائية ومعاملات الحراثة للكثافة الظاهرية بلغت اعلى قيمة 1.50 ميكاغرام.م⁻¹ لمعاملة مياه البئر وبدون حراثة وانخفضت لتصل في اقل قيمها لها 1.34 ميكاغرام.م⁻¹ عند معاملة مياه النهر والحراثة العميقة . افضل حراثة كانت هي الحراثة التقليدية اذ عملت على تحسين صفات التربة الفيزيائية والتقليل من مخاطر استخدام المياه المالحة.

الكلمات المفتاحية: الكثافة الظاهرية، المسامية، بدون حراثة، الحراثة التقليدية، مياه بئر، مياه بزل

INTRODUCTION

The lack of water such as river water leads to increase the demands of water for irrigation purposes. From this point, the need to find alternatives to water as salty water represented by wells water and used them in agriculture. One should take in account the availability of a good management to the water and soil by using as reduces surface cover with salty water irrigation to reduce the dangerous effects and using modern irrigation techniques (9) . It becomes necessary to exploit the subsurface water since the Arab World has a subsurface reserve around 14.3 thousand billion cubic meters (8). The investment of this reserve is low because its renewal rate is very low about 0.3%. One of the major problems in exploiting water resources is the increase of salinity. The most important way to develop and organize water use is to exploit salty water by reducing its poison effect. When using three different types of water to sate their effect on some physical properties of soil, particularly permeability (12) found that the increase of irrigation water salinity leads to increase bulk density and to decrease mean weight diameter. (16) points out that using 10-100 mm.L⁻¹ reduces electrical conductivity of soil because of clay expansion. One of the best means which results in a good management to the soil and exploiting it ideally is the tillage practice (10). Deep tillage reduces bulk density and increases mean weight diameter and hydraulic conductivity (22) . (23 , 5)found that conventional tillage leads to decrease bulk density and gives rise to soil porosity. (4) used four types of tillage: zero tillage (ZT), minimum tillage (MT), conventional tillage (CT) and deep tillage (DT). they found that the highest value of bulk density was at zero tillage (ZT) and lowest was at deep tillage (DT), and the reverse was for the porosity. in his study to three types of tillage at different depths 0, 20 and 30 cm, (11) found that penetration resistance was 1142.8kpa without tillage, but this value was decreased along with the tillage depths. He refers to the fact that soil physical properties were not appropriate without tillage. On the contrary, the soil physical properties were more appropriate at

20 cm depth (1). To compare deep tillage to conventional tillage, the former got the following properties: lower penetration resistance, lower soil bulk density and higher root length density on loam soil across depths (15) on the other hand, Conventional tillage showed lower bulk density, higher water holding capacity and porosity which results in increasing root depth and yield of maize compared to zero tillage (20). The objective of this research, the effect of different tillage systems on physical soil properties and benefit from conventional tillage to decrease the electrical conductivity for water on soil and plant

MATERIALS AND METHODS

A field experiment was conducted in Babylon governorate / Almadhateyia district in Iraq, located along (N: 32°25,25' E: 44°40,030'). The soil was loamy texture. A sample was taken to the laboratory to do some physical and chemical tests before conduction the experiment. Examination ways of soil are used in accordance with (18) Table 1 shows these properties. The experiment was carried out to investigate the saline effect of irrigation water of different sources (w1=river – w2=Drainage – w3=well) water with electrical conductivity (1.3, 3.5 and 6.9) dS.m⁻¹ respectively at stated in the table 1. Different types of tillage were used: zero tillage (ZT), conventional tillage (CT) and deep tillage (DT), devidly. The land site was dividing into three parts, each part was irrigated with a different type of water. The experimental was performed in RCBD with 3 replicatores. thus, the experimental units are 27 (3 water resources * 3 tillage types * 3 replicators), each unit is of 2*2 m² with a space of 0.75 m. the wheat was cultivated, taking into consideration the addition of the fertilizer recommendations. The watering was carried out depending on the need of soil and plant to the water during the growth period always keep the soil in field capacity. After completing the cultivation and harvesting processes, some measures were conducted to the soil, Bulk density mean weight diameter, hydraulic conductivity, porosity and Penetration Resistance.

Table 1. some soil properties of the experimental field before harvest

Property Unit	EC ds.m ⁻¹	pH	CaCO ₃ g.kg ⁻¹	CaSO ₄ g.kg ⁻¹	O.M g.kg ⁻¹	Bulk density Mg.m ⁻³	Particle density Mg.m ⁻³	Hydraulic conductivity cm.h ⁻¹
Value	2.65	7.70	229	1.80	9.80	1.41	2.65	1.70
Property Unit	Ca ⁺² Meq.l ⁻¹	Mg ⁺² Meq.l ⁻¹	K ⁺ Meq.l ⁻¹	Na ⁺ Meq.l ⁻¹	SO ₄ ⁻² Meq.l ⁻¹	HCO ₃ ⁻ Meq.l ⁻¹	Cl ⁻ Meq.l ⁻¹	Texture
Value	12.10	7.80	1.00	10.20	10.90	2.50	13.30	Loamy

Table 2. water properties of the experimental study

Property Unit	EC ds.m ⁻¹	pH	Ca ⁺² Meq.l ⁻¹	Mg ⁺² Meq.l ⁻¹	K ⁺ Meq.l ⁻¹	Na ⁺ Meq.l ⁻¹	SO ₄ ⁻² Meq.l ⁻¹	HCO ₃ ⁻ Meq.l ⁻¹	Cl ⁻ Meq.l ⁻¹	Water quality
River (w1)	1.3	7.45	8.1	2.8	0.30	5.1	6.3	2.1	6.2	C3S1
Drainage (w2)	3.5	7.75	15.1	10.0	1.20	14.4	12.4	3.9	22.3	C4S1
Well (w3)	6.9	7.87	38.3	19.9	0.45	23.6	34.1	7.1	40.1	C4S1

RESULT AND DISCUSSION

Effect of irrigation water quality and tillage treatment on soil physical properties

- bulk density and porosity:

Table 3 show the effect of water quality and tillage treatment on bulk density and porosity. it has been noted that there was a significant effect for the type of irrigation water on bulk density. Bulk density values were 1.40 , 1.44 and 1.47 mg.m⁻³ for w1 , w2 and w3 , respectively. It was found that there was a decrease in soil porosity. it was reduced from 47.3% When irrigating with W1 to 45.8% and 44.3% when irrigated with W2 and W3 and respectively. The reason of increase in apparent density and decrease in porosity in salt water irrigation could be attributed to the collapse of small aggregates and deposited in the spaces within the groupings, which led to the formation of semi-compressed layers which in turn leads to increasing the bulk density and decreasing the porosity (2 , 7) As for the effect of tillage depth, it was found that the bulk density values decreased with increasing tillage depth. while porosity decrease, whose values have increased with

increasing depth. Bulk density values were 1.48, 1.44 and 1.38 mg.m⁻³ for ZT, CT and DT respectively, while porosity values were 44.3 , 45.7 and 47.8 for ZT, CT and DT respectively. The reason for the decline of bulk density when increasing the depth of tillage is attributed to the fact that tillage contributes to the disintegration and fragmentation of soil blocks into small blocks which contributes to increasing Bulk volume ,and increasing porosity. Since the relationship between the volume and the bulk density is not contrast, so increasing the size reduces the bulk density value (17, 5, 11). Some researchers point out that the decrease in bulk density values at conventional tillage compared to other types of tillage is because tillage is breaking the soil-subsurface to produce loose soil. It has been documented that zero tillage gives high penetration resistance compared with other tillage types (1). For the relationship between irrigation water salinity and tillage depth, it has been found that the highest value (1.50) mg.m⁻³ obtained at ZT and W3, while the lowest value (1.34) Mg.m⁻³ obtained at DT and W1.

Table 3. Effect of water quality and tillage systems on bulk density and porosity

Soil property		W1	W2	W3	Average
Bulk density mg. m ⁻³	ZT	1.45	1.48	1.50	1.48
	CT	1.40	1.45	1.47	1.44
	DT	1.34	1.38	1.43	1.38
Average		1.40	1.44	1.47	
L.S.D			0.30		
Porosity %	ZT	45.3	44.2	43.4	44.3
	CT	47.2	45.3	44.5	45.7
	DT	49.4	47.9	46.0	47.8
Average		47.3	45.8	44.7	
L.S.D			0.96		

-Mean Weight Diameter (MWD)

Table 4 state that there a decline in value of mean weight diameter when increasing the

irrigation water salinity. It decreased from 0.65mm when using W1 to 0.50, 0.27mm when using W2 and W3, respectively. This is

due to the negative role of salts on the accumulation of soil particles that lead to dispersion and deterioration of soil construction (8). As for the effect of the tillage treatment, it was found that the value of mean weight diameter was reduced from 0.50 mm at ZT to reach 0.49 mm and 0.44mm at the CT and DT, respectively. This is due to the role of

tillage in soil disintegration, leading to a decrease in the mean weight diameter values, (14) In terms of the intersection between the quality of irrigation water and the level of tillage, it was found that the highest level was 0.73 mm at Zt and W1. The lowest MWD value was 0.25 mm at Dt and W3.

Table 4. Effect of water quality and tillage systems on mean weight diameter

Soil property		W1	W2	W3	
Mean Weight Diameter (MWD) mm	Zt	0.73	0.50	0.28	0.50
	Ct	0.64	0.53	0.30	0.49
	Dt	0.59	0.48	0.25	0.44
L.S.D		0.65	0.50	0.27	
			0.65		

- Penetration Resistance

Table 5 show the impact of irrigation water quality on the values of penetration resistance. This value increased with the increase of irrigation water salinity, it increased from 377kpa at W1 to be 403kpa and 445kpa at W2 and W3, respectively. This is because of the effect of salty water which separates and deposits the soil particles at the spaces making up adhesive material (21). This process will lead to gathering the salts at the surface layer to make a solid shell increasing penetration resistance. Concerning the effect of tillage on the values of penetration resistance, it has been

found that there is a significant effect at the least 0.05%. The value decreased with the increase of tillage depth, it reached 447.7kpa at Zt while it falls to 396.3 kpa and 371.7 kpa at Ct and Dt, respectively. This is due to the fact the tillage depth has improved some soil physical properties such as increasing the volume humidity content of the soil and improved the drainage conditions and decreased the bulk density (6, 3) About the interaction between the quality of irrigation water and level of tillage, the highest value was 478kpa at Zt and W3 while the lowest was 340 kpa at Dt and W1.

Table 5. Effect of water quality and tillage systems on penetration resistance

Soil property		W1	W2	W3	
Penetration Resistance kpa	Zt	420	445	478	447.7
	Ct	371	395	423	396.3
	Dt	340	370	405	371.7
L.S.D		377	403.3	435.3	
			3.85		

- Hydraulic conductivity

Table 6 shows that hydraulic conductivity, values have been affected by water salinity and tillage systems. And their values were decreased with increasing salinity of irrigation water, values were (5.13 , 4.26 and 4.36 cm.h⁻¹ when irrigated by derange and well water respectively, The reason for this is that the salt water is working on the construction of soil structure, which works on low porosity due to

the close of large pores interfaces (19, 13) As for the effect of tillage systems, there was a significant increase in the values of hydraulic conductivity values increased from 2.4 to 4.6 to 6.8 cm.h⁻¹ for ZT , CT and DT respectively .This is due to the deterioration of soil structure , the high soil resistance values for penetration and the change in the value of soil porosity and the volume distribution of pores (24).

Table 6. Effect of water quality and Tillage systems on Penetration Resistance

Soil property		W1	W2	W3	
Penetration Resistance kpa	Zt	420	445	478	447.7
	Ct	371	395	423	396.3
	Dt	340	370	405	371.7
L.S.D		377	403.3	435.3	
			3.85		

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