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ORIGINAL

The effect of using river water magnetization on corn yield and the properties of irrigation water and soil

Efecto de la magnetización del agua de río sobre el rendimiento del maíz y las propiedades del agua de riego y del suelo

Alaa Imad Hameed[1], Nadira Abbas Mohammad[1]

[1]Technical Institute, Northern Technical University, Iraq.
[2]College of Agricultural Technology, Northern Technical University, Iraq.

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ABSTRACT

This study aims at studying the effect of using two different intensities of magnetization of irrigation water on some properties of irrigation water and soil and on the yield of corn. The field of corn is divided into three sectors (R1: non-magnetized river water, R2: magnetized river water with 1000 gauss, R3: magnetized river water with 3000 gauss. Examinations are made on the physical and chemical properties of the irrigation water, EC, PH, anions and cations for both water and soil as well as the productivity of the corn plant. The results indicate that the magnetization of irrigation water with an intensity of 1000 gauss (R2) had a positive effect on all properties of soil, water and moisture content in addition to productivity. Where the value of total dissolved salts (TDS), EC, and the values of K, Na, Mg, and Ca ions decreased for irrigation water. While the PH value of irrigation water increased at R2, this increase in pH may be due to the formation of more bicarbonate, calcium and hydroxide ions, which reduce acidity. With stability the value of these characteristics at the intensity of 3000 gauss (R3), the matter which indicates that this intensity is not useful for improving water properties. An increase in the value of (N, B, K) was observed in both leaves and seeds of corn when magnetized at an intensity of 1000 gauss. The magnetization of irrigation water at an intensity of 1000 gauss increases the yield of corn plant more than the magnetized 3000 gauss.

Keywords: Magnetization; Yield of Corn; Total Dissolved Salts; Water Properties; Electrical Conductivity.

RESUMEN

Este estudio tiene por objeto estudiar el efecto de la utilización de dos intensidades diferentes de magnetización del agua de riego sobre algunas propiedades del agua de riego y del suelo y sobre el rendimiento del maíz. El campo de maíz se divide en tres sectores (R1: agua de río no magnetizada, R2: agua de río magnetizada con 1000 gauss, R3: agua de río magnetizada con 3000 gauss. Se examinan las propiedades físicas y químicas del agua de riego, CE, PH, aniones y cationes tanto del agua como del suelo, así como la productividad de la planta de maíz. Los resultados indican que la magnetización del agua de riego con una intensidad de 1000 gauss (R2) tuvo un efecto positivo sobre todas las propiedades del suelo, el agua y el contenido de humedad además de la productividad. Donde el valor de sales totales disueltas (TDS), EC, y los valores de los iones K, Na, Mg, y Ca disminuyeron para el agua de riego. Mientras que el valor del PH del agua de riego aumentó en R2, este aumento del pH puede deberse a la formación de más iones de bicarbonato, calcio e hidróxido, que reducen la acidez. Con la estabilidad el valor de estas características en la intensidad de 3000 gauss (R3),

la cuestión que indica que esta intensidad no es útil para mejorar las propiedades del agua. Se observó un aumento del valor de (N, B, K) tanto en las hojas como en las semillas de maíz cuando se magnetizaron a una intensidad de 1000 gauss. La magnetización del agua de riego a una intensidad de 1000 gauss aumenta el rendimiento de la planta de maíz más que la magnetizada a 3000 gauss.

Palabras clave: Magnetización; Rendimiento de Maíz; Sales Totales Disueltas; Propiedades del Agua; Conductividad Eléctrica.

INTRODUCTION

Magnetic technology is an ancient science where its importance has been discovered recently. Magnetic energy plays an important role in the life of living organisms and it has been applied in fields of several countries including agricultural fields.[1]

The state of the relationship of magnetization with soil, water and salt is the basis of the magnetic method, which works to change the physical and chemical properties of ordinary water. This leads to an improvement in the solubility capacity, this is why the separation of salts from the soil becomes much better and thus the absorption of nutrients and fertilizers becomes better during the growth period.[2] Mohamed (2013) stated that irrigation water, which was subjected to a magnetic field of 250 mT to a significant increase in branches and roots and improved growth and productivity and the electrical conductivity of the soil decreased.[3]

Nasher (2008) also showed that magnetized water has a positive effect on seeds, crops growth and plant height which increase significantly, increase the solubility of salt in water and provide seeds with nutrients from the soil.[4] Hozayn et al. (2013) found that the use of magnetized irrigation water increased the percentage of root length and plant productivity at 5,27 % and 23,7 %, respectively.[5] Mohammed et al. (2010) explained that the use of magnetized water from 50-150 mT in irrigation of plants led to a significant increase in plant height, leaf area and dry weight compared with tap water.[6] Mostafa (2020) stated that the process of magnetizing irrigation water and then adding fertilizer have a positive effect on plant measurements (number of plants and plant height), and this leads to an increase in productivity by 40,5 %.[7]

There are several studies linking magnetic treatment of irrigation water with increased growth in crops, such as the study of Maheshwari and Grewal (2009), they showed the effect of magnetization of irrigation water on the productivity of peas and celery plants, and tap water was used (before and after magnetization), recycled water and saline water, where magnetization increased productivity by 12 %, 23 %, 12 % for celery crop, by 7,8 %, 5,9 %, 6 % of pea yield in comparison with unmagnetically treated water. Abdulraheem et.al 2021 indicated that using the intensities of 1000 gauss and 3000 gauss with several irrigation water salinity concentrations of 0,7, 4 and 8 ds/m, and it was found that the magnetization intensity of 1000 gauss increased the germination of sunflower more than 3000 gauss.[8]

This study aims at studying the effect of using two intensities of magnetization, 1000 gauss and 3000 gauss, and their effect on the physical and chemical properties of water and soil, which increase soil fertility and thus plant productivity.

Materials and Methods

The work in the current study includes locating and preparing the land in the area of Bakra Joe the outskirts of Sulaymaniyah Governorate, affiliated to the Water Resources Centre and Studies for Northern Region Projects. Then dividing the field into three sectors (R1: non-magnetized river water, R2: magnetized river water with 1000 gauss, R3: magnetized river water with 3000 gauss).

The distance between each of them is 3m in order to avoid water interpenetration of different qualities, and each sector contains five experimental units with an area of (5m * 4m) for each unit, and the distance between each of them is 4m, as shown in figure 1.

Autumn corn was planted in July and harvested in November, yellow corn needed 80 kg / dunum of nitrogen and 50 [kg] of phosphorus pent oxide / dunum as directed by the Ministry of Agriculture, and the addition shall be in two instalments, the first at the rate of 40 [kg / dunum] when planting the addition of nitrogen-containing fertilizer was in the form of urea, which contains (46 % N), and the second was after 45 days of planting. Because the yellow corn plant needs the two elements nitrogen and phosphorus, so phosphorus was added to the field and to each treatment before planting.

The process of weeding was carried out manually to remove the bush periodically during each season, then spraying Nokoz, an insecticide, on ants and other insects.

Sowing of yellow corn started in July in form of lines. The distance between one repeater and another 1[m] and between each experimental unit and another 0,75m. And put three seeds in each hole as a precautionary measure in case that one of the seeds did not germinate, and after a week of planting, the plants appeared and the distance between each seed was 25 cm, and the irrigation process was carried out according to the needs

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of the plants. The lengths and dimensions of the corn plant leaves were measured, and physical and chemical properties of the soil and irrigation water were measured, and the effect of magnetization on the growth and productivity of the corn plant was shown.

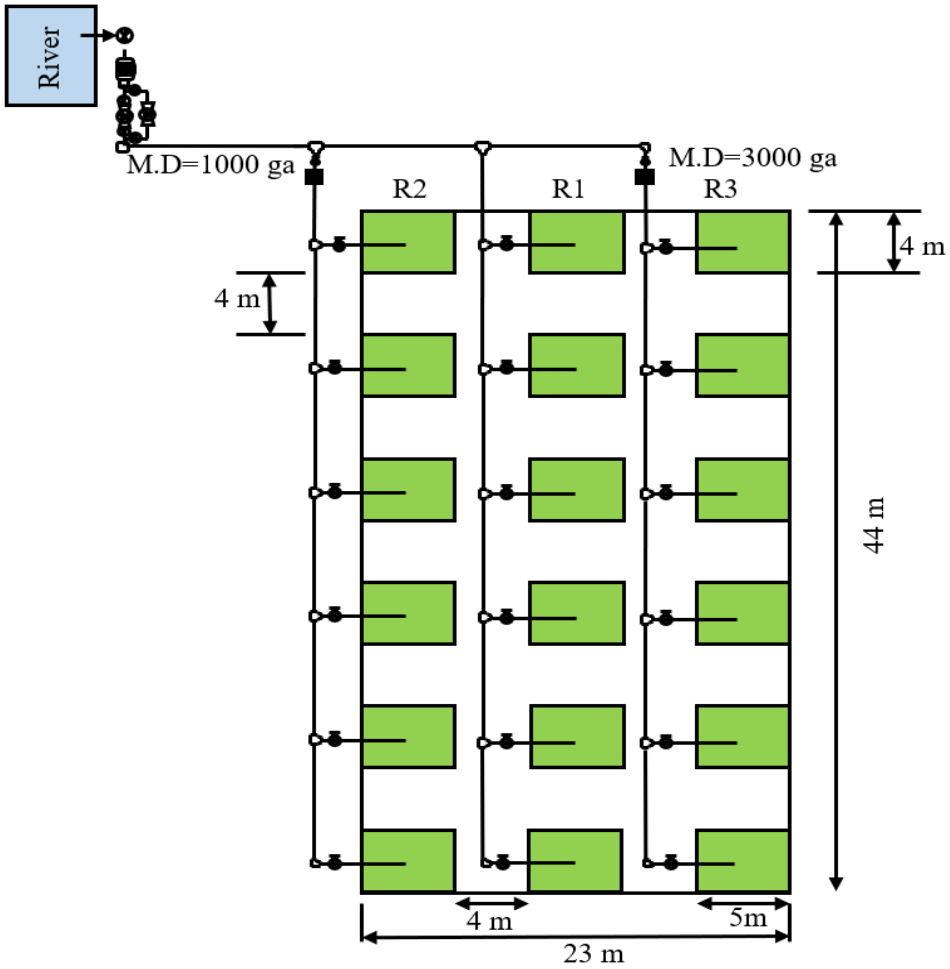

Figure 1. Distribution of the treatments in the experimental land for the yellow corn

Laboratory work was carried out in each of the Centre for Engineering Studies and Designs / Department of Studies and Engineering Designs in Mosul and in the Directorate of Agriculture in Nineveh, tests were conducted as well in the College of Agriculture / University of Mosul and included physical and chemical tests for water and soil.

RESULTS AND DISCUSSION

Irrigation water properties

Down below is table 1 which includes both physical and chemical tests of the irrigation water before and after magnetization:

Table 1. some of physical and chemical properties of irrigation water

Characters	Unit	Before magnetization (R1)	After magnetization (R2, 1000 [G])	After magnetization (R3, 3000 [G])
TDS		290	220	220
K	[ppm]	0,85	0,74	0,74
Na	[ppm]	8,7	6,9	6,9
Mg	[Meq/L]	11,5	7	7
Ca	[Meq/L]	14,5	13	13
PH		6,5	7,1	7,1
Cl	[Meq/L]	1,75	2	2,5
EC	[ds/m]	0,595	0,43	0,43

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From table 1, a decrease was observed in the value of salinity in the sample (TDS) at 24 %. as a result of exposure to a magnetic field of 1000 gauss (R2), which led to the dissolution of salt molecules and liberation of free ions and help to unite with insoluble compounds that can be absorbed by the plant. This can be seen in that water molecules (H2O) are linked to each other by hydrogen bonds, and these bonds may be double or multiple which may reach dozens of bonds. When these molecules are exposed to the magnetic field, these bonds change from one angle to another during the hydrogen ion contact with the oxygen, and thus leads to an increase in the susceptibility to electrolysis and the effect on the decomposition of the salt crystals.

The goal of the water magnetization is to convert large crystals into small crystals that facilitate their passage through plant roots and soil pores. Therefore, the amount of salts in the water does not decrease, but they are not harmful. It facilitates the passage of small salt particles through soil pores and then to the drains in the lower soil layers.[9] This indicates that the magnetization of water with a strength of 1000 gauss has a positive effect in adapting the irrigation properties for agricultural uses.

While stability was observed of the TDS value at magnetization with a strength of 3000 gauss, which indicates that this intensity is not useful in improving the properties of irrigation water, and this agrees with [10] but the experiment was about germination of the sunflower.

It was also noted from Table 1, the decrease in the value of (EC) at 27 % because it is related to the parameter (TDS), as mentioned.[11] It was also noted from table 1, the value of the K, Na, and Mg ions are decreased at (13 %, 21 %,39 %) respectively when the water is magnetized at an intensity of 1000 gauss, this may be due to the reduction of the effect of metal ions caused by crystallization and sedimentation process resulting from the magnetic treatment as mentioned.[12] Also, because the magnetization process has an effect on metal ions, as it increases the absorption of minerals as well as on salt ions, as it increases the property of dissolving salts, breaking them down and converting them into very small particles which reduces the concentration of salts in the soil and irrigation water, as mentioned.[7]

With the value of these ions proven at the intensity of 3000 gauss, which indicates that this intensity is not useful for improving water properties.

The results also showed a decrease in calcium ion after magnetic treatment at 11 %, and this can be shown by the lack of CO2 at the reaction due to the high temperature, and when the CO2 decreases, it leads to the course of the reaction in the reverse direction, and thus the calcium ion decreases, refer with: Equation 1.[9]

$$CO2+H2O+CaCO3 \rightleftharpoons Ca^{++}+2HCO3^{-} \quad (1)$$

It was also noted from table 1, that the pH value increases by magnetization at a value of 1000 gauss (R2), from 6,5 to 7,1 in the rate of +10 %, then this value is fixed at 3000 gauss (R3), and this increase in the pH may be due to the formation of more bicarbonate, calcium and hydroxide ions which reduces acidity.[7,13]

Soil properties

The results showed, as shown in table 2, that the soil PH value (before planting) decreases at 11 % using magnetization with an intensity of 1000 gauss and remains constant at 3000 gauss, which indicates that the 3000 gauss intensity does not have a positive effect on soil properties. This is due to the fact that the size of the particles in the magnetized water are half the size of the particles of the non-magnetized water, and it makes it possible to achieve high permeability between cellular membranes and reduce the hydrogen ion concentration per unit volume.[7,14]

The magnetic field also affects the organic matter in the soil and works to lower the acidity of the soil PH and helps to absorb the highest number of organic acids in the soil surrounding the root as indicated by [8,12].

Table 2. Effect of Magnetization of irrigation water on some properties of soil

Water treatment			Properties
After magnetization (R3, 3000 [G])	After magnetization (R2, 1000 [G])	Before magnetization (R1)	
6,1	6,1	6,9	PH
707	707	790	EC
56	98	70	N (ppm)
0,47	0,76	0,15	P (ppm)
3	3	2	K (ppm)

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1,7	1,7	1,98	Bulk intensity gm/cm3
0,02	0,02	0,025	So_4 %
7,2	9	7,6	Water Content %
21,8	26,4	28	Co_3 %

It was also shown in table 2, that the value (EC) of the soil decreases when intensity magnetized was 1000 gauss (R2), at ratio 10 %, and remains constant at 3000 gauss (R3). The results show that magnetization is one of the techniques in the modern era in reducing the accumulation of salt in the soil and improving the soil conditions around the roots of plants, where the properties of water dissolving increase, because when the water molecules are magnetized, they are smaller and their viscosity is lower.

As well as the speed of movement is greater and the permeability in the pores of the soil increases, and this agrees with what was stated in [12,15]. The reason for the decrease of (EC) is preventing the accumulation of salts, these results accord with those of [7,16].

The results showed an increase in the value of (N, P and K) in the soil when irrigated with 1000 G magnetized water in the rate of (40, 80, 50) % respectively, while there was no significant effect when irrigated with 3000 G magnetized water.

In addition, and through the results shown in Table 2, a decrease in the value of the sulphate ion was observed at rate 20 % and the decrease of the sulphate ion reduces the chances of precipitation of calcium sulphate in the soil and increases the chance of salt leaching from the soil as mentioned.[9,17] The results also indicate in Table 2, the effect of magnetized water on the bulk intensity of the soil, where its value was 1,98 g /cm3 before magnetization and became 1,7 g /cm3 at magnetization with an intensity of 1000 gauss at rate 16 %, and remains constant at 3000 gauss.

This is because the magnetized water dissolves and washes the salt which works to prevent accumulations in the soil and leads to making good soil.[2]

Noted by table 2, an increase in the moisture content of the soil when the irrigation water is exposed to magnetization with an intensity of 1000 gauss at 12 %, due to the increase in the soil's ability to retain water and the reduction of deep infiltration, which increases soil moisture.[18]

Results Hamza et al., 2021 indicated that water treatment with magnetic field reduces the angle of water contact and increases the ability of water to enter the micro-pores of the soil, and thus provides a higher capacity of the soil to retain water compared to the soil irrigated with non-magnetized water.[19]

A decrease has also been observed in the value of carbonate ions (Co3) in the soil when the irrigation water is magnetized, because in non-magnetic water carbonates are deposited in the pores of the soil and on the plant roots, but using magnetic water the carbonate salts do not precipitate and the salts deposited on the inner surface of the irrigation pipes can be broken down, and thus the movement of the water will be easier than in non-magnetic water.[12]

While it was observed that, the value of PH decreased at a magnetization intensity of 1000 gauss because it releases greater of organic acids in rhizosphere this is consistent with.[7,12]

The effect of magnetization of irrigated water on some characteristics of corn leaves

The results in table 3, indicate the effect of magnetization of irrigation water with several intensities on some characteristics of corn leaves:

Table 3. Effect of Magnetization of irrigation water in some growth characteristics of corn leaves

Properties	R1	R2	R3
Zn [ppm]	120	320	250
Fe [ppm]	390	426	400
N %	0,28	0,84	0,56
P %	0,04	0,09	0,08
K [ppm]	8	15	2

From table 3, it was observed that the value of (Zn, Fe) increased at 62 %, 9 % respectively, and the value of (N, P, K) increased when magnetized with an intensity of 1000 gauss at rate (66, 55, and 87) % respectively, while there was no effect when magnetized with an intensity of 3000 gauss. This shows the benefit of intensity magnetization of 1000 gauss in improving corn leaves, this statement agrees with [20] but the study was on olive leaves.

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The effect of magnetization of irrigation water on some characteristics of corn seeds

The results in Table 4, show the effect of magnetization of irrigation water with several intensities on some characteristics of corn seeds:

Table 4. Effect of Magnetization of irrigation water in some growth characteristics of corn seeds

Properties	R1	R2	R3
Zn [ppm]	48	57	57
Fe [ppm]	130	294,6	294,6
N %	1,68	2,24	1,96
P %	0,26	0,31	0,16
K [ppm]	14	15	6

From table 4, it was observed that the value of (Zn, Fe) increased at rate 18 %, 55 %, and the value of (N, P, K) increased at rate (33,19,7) % respectively when magnetized with an intensity of 1000 gauss, while there was no effect when magnetized with an intensity of 3000 gauss. This indicates the benefit of intensity magnetization of 1000 gauss in improving corn seeds, this statement agrees with [21] but the study on Cucumber Plants.

The effect of magnetization of irrigation water on some characteristics of corn plant growth and productivity

The results in table 5, show the effect of magnetization of irrigation water with several intensities on some characteristics of growth and productivity of corn plant.

Table 5. Effect of Magnetization of irrigation water in some growth characteristics and yield of yellow corn

Growth characteristics	Water treatment			
	Before magnetization (R1)	After magnetization (R2, 1000 [G])	After magnetization (R3, 3000 [G])	Percentage of increase
Plant height [cm]	150	170	155	13 %
No. of leaf	14	16	13	14 %
Width of leaf [cm]	8,2	9,2	8	12 %
Yield [kg] before peeling	27,2	36,6	26,6	34 %
Yield [kg] after peeling	21,8	23,9	17,1	10 %

Noted by table 5, an increase in plant height when magnetized with an intensity of 1000 gauss at rate 13 %, as the magnetization of water reduces the resistance of cell walls to cell elongation during the growth process, in addition to reducing the surface tension of water and thus makes the plant absorb water and nutrients from the soil easily and with less effort, and as Male.[1,22]

The increase in plant height and the number of leaves is caused by stimulating effect of the magnetic process, which may be due to the increase in the absorption of nutrients as stated in the research of [7]. Also in table 5, it has been noted that the magnetization of water irrigation with an intensity of 1000 gauss increases the yield of corn plants by 34 %, while the effect was less when magnetizing with an intensity of 3000 gauss, and this accords with [10].

CONCLUSION

The results proved that the process of magnetizing irrigation water with an intensity of 1000 gauss has a positive effect on all soil, water and moisture content properties in addition to productivity. While the value of total dissolved salts (TDS), EC, and the values of K, Na, Mg, and Ca ions decreased in irrigation water. While the PH value of the irrigation water increased at R2, with the value of these properties remaining constant at the intensity of 3000 gauss (R3), which means that this intensity is not useful for improving water properties.

As has been noted the low pH, electrical conductivity, sulphate ion, and soil bulk intensity at R2. An increase in the value of (N, P, K) was also observed in both leaves and seeds of corn when magnetized at an intensity of 1000 gauss. The results also showed that the magnetization of irrigation water with an intensity of 1000 gauss increases the productivity of corn plants more than the magnetization with an intensity of 3000 gauss.

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Conceptualization: Alaa Imad Hameed, Nadira Abbas Mohammad.
Research: Alaa Imad Hameed, Nadira Abbas Mohammad.
Writing - original draft: Alaa Imad Hameed, Nadira Abbas Mohammad.
Writing - revision and editing: Alaa Imad Hameed, Nadira Abbas Mohammad.