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# THE EFFECT OF PLANT RESIDUES, IRRIGATION WATER QUALITY AND POTASSIUM LEVELS ON *TRITICUM AESTIVUM* GROWTH

**Lyaly Ghazy Saham, Abdul Kareem Hassan odhafa and Azher Hameed Al-Taie***
Wasit University, College of Agriculture, Soil Science and Water Resources, Wasit, Iraq
*Corresponding author: aaltaie@uowasit.edu.iq

**Abstract**

The experiment has been applied in the College of Agriculture- Wasit University, for the season 2021/2022. Ibaa 99 wheat cultivar has been planted using the complete randomized design (CRD). The study aims were to evaluate the different levels of salinity irrigation water alternating with fresh water and, its effect on the growth and production of wheat *Triticum aestivum*. The results have been showed that the unburned soil has been recorded the highest values in some of the studied traits including plant height, grain yield, spike length, biological yield, number of branches, number of spikes, and K, P, N content. Also, there was a response to potassium fertilization. The best level was the second level K2250 kg. This concentration has been recorded the highest values for the studied traits including plant height, grain yield, spike length, biological yield, number of branches, number of spikes. The effect of salinity irrigation water was clear in all the studied traits. The first level 1.2 dS $m^{-1}$ has been recorded the highest values for all the studied traits. On the other hand, the second level 4 dS $m^{-1}$ was the lowest values.

**Key words**: plant residues, irrigation water, potassium *Triticum aestivum*

## Introduction

The wheat *T. aestivum* is one of the strategic grain crops in Iraq. It has been ranked as first in terms of production and cultivated areas. It is a source of essential amino acids, vitamins, minerals, dietary fiber and useful phytochemicals (Arzani & Ashraf, 2017) . Wheat production was estimated at (4234) thousand tons for the winter season (2021), with decrease of (32.1%). Wasit Governorate has been occupied the first place in terms of grain production, which was estimated at (810) thousand tons at a rate of (19.1%) of the total production, followed by Al-Qadisiyah Governorate, Salah Al-Din , Diyala .

Organic waste is one of the effective strategies in reducing the damage of salinity irrigation water and increasing plant tolerance. It improves the distribution of soil pores, which increases water holding capacity and improves the secretions of roots such as organic acids that regulate soil pH and reduce the harmful effect of salts in the soil solution(Harman et al., 2021; Meena et al., 2018). The organic waste has been also played a role in sodium ion washing and reduces of the exchanged sodium ratio and electrical conductivity (Bhateria & Jain, 2016). It also works to modify the nutritional balance in the soil, which is disturbed by the presence of an increase of certain ions at the expense of necessary nutrients, improving the ventilation conditions and the movement of oxygen. Therefore, increase the vital activity and the readiness of nutrients in the soil(Clarkson & Hanson, 1980; Hillel, 2000). (Yaqub et al., 2021) has been indicated that the effect of the quality of salts and organic matter on the electrical conductivity values in the soil of the Abu Ghraib area. It has been found that the addition of organic led to an increase in the electrical conductivity values.

(Ghallab & Usman, 2007; Horneck et al., 2007) have been indicated that the use of saline irrigation water caused an increase in the electrical conductivity of the soil and exchange capacity of positive ions (CEC).

**Materials and methods**

Experiment location

The field experiment was applied in the College of Agriculture- Wasit University for the season 2021/2022. The samples of bringing soil were collected from a field planted with wheat from Numaniyah district. Soil was classified according to the modern American classification to a level below the high groups within the order Typic- Torrifluvent according to (Soil Survey Staff, 2006). Soil samples were taken before planting for the purpose of analysis and estimation of some chemical and physical trails.

**Soil sample collection**

Soil has been collected from one of the wheat cultivation sites, Numaniyah district. It was after the end of the last agricultural season 2020-2021. It was by choosing a part of the field after conducting the burning process for the plant residues. The other part was chosen without burning the plant residues. The surface layer of the soil represented the burned part, and the other part is the subsurface layer to represent the part of the soil not affected by the burning process. Each of the mentioned parts was placed in bags. The soil was placed in plastic pots with a capacity of (10) kg of soil, with dimensions of 25 x 25 x 25 cm. The lower layer represents the unaffected part of burning to a depth of (10-20 cm), while the upper part (0-10) cm represents the surface layer of the burnt plant residues. The symbol M1 was given in isolation from the pots, while the soil for the unburned surface layer was symbol M2.

Table (1) some chemical and physical trails of soil (before planting)

| Trails | | Normal soil | Unburned soil | Burned soil | Measurement unit |
|---|---|---|---|---|---|
| pH(1:1) | | 7.78 | 7.72 | 7.73 | - |
| EC | | 2.43 | 2.47 | 2.49 | DSi $m^{-1}$ |
| cation exchange capacity | | 23.1 | 26.4 | 19.7 | kg-1 soil |
| Organic | | 6.1 | 8.2 | 5.46 | g/$kg^{-1}$ soil |
| Dissolved positive ions | $Ca^{+2}$ | 14 | 14.12 | 14.06 | mmol $l^{-1}$ |
| | $Mg^{+2}$ | 12.38 | 12.28 | 12.24 | mmol $l^{-1}$ |
| | $Na^{+}$ | 9.46 | 9.4 | 9.26 | mmol $l^{-1}$ |
| | $K^{+}$ | 0.44 | 0.4 | 0.22 | mmol $l^{-1}$ |
| Dissolved negative ions | $HCO3^{-}$ | 4 | 4.6 | 4.2 | mmol $l^{-1}$ |
| | $SO4^{-2}$ | 7.8 | 13.4 | 13.18 | mmol $l^{-1}$ |
| | $Cl^{-}$ | 18 | 18.2 | 18.6 | mmol $l^{-1}$ |
| | $CO3^{=}$ | Nil | Nil | Nil | - |
| Nitrogen | | 36.0 | 32.1 | 28.7 | mg/$kg^{-1}$ soil |

| | | | | | |
|---|---|---|---|---|---|
| phosphorous | | 16.4 | 16.8 | 16.2 | mg/kg$^{-1}$ soil |
| potassium | | 72.4 | 78.3 | 67.8 | mg/kg$^{-1}$ soil |
| gypsum | | 0.022 | 0.023 | 0.022 | g/kg$^{-1}$ soil |
| lime | | 23.1 | 23.4 | 23.1 | |
| Soil Separators | Sand | 253.6 | 3.250 | 251.2 | g/kg$^{-1}$ soil |
| | Silt | 366.3 | 368.4 | 367.5 | g/kg$^{-1}$ soil |
| | Mud | 380.1 | 381.3 | 381.3 | g/kg$^{-1}$ soil |
| Texture class | | | | | - |
| Density | | 1.33 | 1.33 | 1.36 | mg$^{-3}$ |

**Fertilization**

Urea fertilizer (N 46%) was added at a rate of 200 kg nitrogen/ h$^{-1}$. Two batches have been used, the first at planting and the second after 45 days of planting. Triple superphosphate fertilizer (20%P) was added at a rate of 80 kg/ h$^{-1}$ at the planting (AL-Abody et al., 2021; Kadum Maha et al.). Wheat seeds (Aba 99 cultivar), supplied by the Department of Seed Inspection and Certification, Wasit Branch/ Ministry of Agriculture, have been used in plastic pots. The date of planting was on November 28, 2021 with 10 seeds per pot.

The seeds were close in size and healthy once. Weeds were removed manually and regularly, and all pots were covered with a plastic cover to protect them from rainwater contamination during the germination stage. In the maturity stage, all the pots were covered with a net to keep them from birds. All pots were irrigated with fresh water at the beginning of planting to ensure the process of seed germination. The saline irrigation water was added to the planted pots with S1 and S2 types of water in the same quantities and by the weight method.

**Irrigation water levels**

The saline water was brought from one of the drains located in the Al-Hussainiya area (Al-Ahrar district, Wasit). It was transferred to the experiment site. To obtain two levels of salinity irrigation water (1.2,4), which have the symbol S1 and S2, the following equation was applied (FAO, 1985): Electrical conductivity of mixing water = (Electrical conductivity of river water x part of river water used) + (Electrical conduction of drain water x part of drain water)

Table (2) some chemical trails of the irrigation water

| trails | units | S1 | S2 |
|---|---|---|---|
| **pH** | - | 7.5 | 7.2 |
| **EC** | **dsm$^{-1}$** | 1.1 | 3.7 |
| **$Ca^{+2}$** | mmol.l$^{-1}$ | 2.5 | 3.3 |
| **$Mg^{+2}$** | | 1.7 | 2.7 |
| **$K^{+}$** | | 0.03 | 0.09 |
| **$Na^{+}$** | | 5.6 | 8.0 |
| **$_3CO^{2-}$** | | NIL | NIL |

| | | | |
|---|---|---|---|
| **$_3HCO^-$** | | 3.0 | 4.3 |
| **$CL^-$** | | 4.2 | 6.8 |
| **$4SO^{-2}$** | | 2.63 | 2.99 |
| **SAR** | | 3.88 | 4.62 |

**The field experiment**

The field experiment was applied using (CRD) design with three replications for each treatment; amounting to (96) experimental units. They were randomly distributed to the experimental units, according to the following details of the experiment factors:

A- The first factor: use two types of surface layer of soil for a field planted with wheat, which are:

1- Burned Soil plant residues (M1).

2- Unburned soil, plant residues (M2).

B - The second factor: use two levels of salinity irrigation water, which are:

1- 1.2 dSi m and its symbol was 1S (fresh irrigation water).

2- 4 dSi m and its symbol was 2S (salt irrigation water).

The third factor: adding potassium fertilizers (potassium sulfate 4OS2K)

1- 125 kg K and its symbol was K1

2-250 kg K and its symbol was K2

**Chemical analyzes of soil and water:**

**pH soil**

The estimation was done in the soil extract (1:1) using a Phmeter device as described by (Page et al., 1982).

**Electrical conductivity Ec**

The estimation was used a meterconductivity device in soil extractor leachate (1:1) as described by (Page et al., 1982).

**Results and Discussion**

**The soil pH**

The results have been showed a significant decrease in the pH of unburned soil (M2), while in the treatment of salinity irrigation water, the treatment 2S have been recorded (7.63) $dSm^{-1}$(Table 4,5). In the S1 treatment, it has been found that the highest value of 7.80 $dSm^{-1}$, and the percentage of decrease in unburned soil was 2.22%. Howerver, the value in the burned soil (M1), the pH soil in second level (S2) was 7.21, while the treatment S1 has been recorded the highest value, which was 7.40 $dSm^{-1}$ with increasing of 2.56% for burned soil (Tables 4 and 5).

This reason can be attributed to the decrease in the values of the pH by increasing the salinity levels of the irrigation water to the accumulation of neutral salts such as chlorides, sulfates, and each of magnesium, sodium and calcium. Therefore, it will press on the values of the pH soil of the soil solution towards neutrality in the soil, which caused a decrease in the soil pH. These results

are agreed with(Fipps, 2003; Hopkins et al., 2007), which indicated a decrease in the pH soil towards neutrality with an increase in the salinity of irrigation water. For unburned soil (M2), the first level K1 has been recorded the lowest average, which reached 7.71. The second level K2 was 7.72. The results have been indicated that adding potassium fertilizer to the first level K1 and average of 7.36, while the second level of potassium has been recorded 7.25 kg/h. The potassium fertilizer plays a role to improve the pH soil(Acquaye & MacLean, 1966; Greenwood et al., 1980).

Table (4) effect the irrigation water, potassium fertilizer on the PH of unburned soil

| treatments | Potassium (K) kg/h | irrigation water $dSm^{-1}$ | | T*K |
|---|---|---|---|---|
| | | S1 | S2 | |
| T1 | K1 | 7.81 | 7.51 | 7.66 |
| | K2 | 7.73 | 7.62 | 7.68 |
| T2 | K1 | 7.83 | 7.54 | 7.68 |
| | K2 | 7.74 | 7.74 | 7.74 |
| T3 | K1 | 7.88 | 7.60 | 7.74 |
| | K2 | 7.80 | 7.71 | 7.75 |
| T4 | K1 | 7.85 | 7.78 | 7.76 |
| | K2 | 7.78 | 7.66 | 7.72 |
| $LSD_{T*K*S}$ | | N.S | | N.S |
| T*S | | | | |
| treatment | | S1 | S2 | Mean T |
| T1 | | 7.77 | 7.57 | 7.67 |
| T2 | | 7.79 | 7.64 | 7.71 |
| T3 | | 7.84 | 7.65 | 7.75 |
| T4 | | 7.82 | 7.66 | 7.74 |
| $LSD_{T*S}$ | | N.S | $LSD_T$ | N.S |
| K*S | | | | |
| K | | S1 | S2 | Mena K |
| K1 | | 7.84 | 7.58 | 7.71 |
| K2 | | 7.76 | 7.68 | 7.72 |
| $LSD_{K*S}$ | | 0.07 | LSDk | N.S |
| S | | | | |
| S | | S1 | S2 | |
| S Mean | | 7.80 | 7.63 | |
| LSDs | | 0.05 | | |

Table (5) effect the irrigation water, potassium fertilizer on the PH of burned soil

| treatments | Potassium (K) kg/h | irrigation water $dSm^{-1}$ | | T*K |
|---|---|---|---|---|
| | | S1 | S2 | |

| | | | | |
|---|---|---|---|---|
| **T1** | **K1** | **7.41** | **7.23** | **7.32** |
| | **K2** | **7.32** | **7.11** | **7.22** |
| **T2** | **K1** | **7.43** | **7.25** | **7.34** |
| | **K2** | **7.34** | **7.15** | **7.24** |
| **T3** | **K1** | **7.48** | **7.31** | **7.39** |
| | **K2** | **7.39** | **7.21** | **7.30** |
| **T4** | **K1** | **7.45** | **7.35** | **7.37** |
| | **K2** | **7.35** | **7.16** | **7.26** |
| **$LSD_{T*K*S}$** | | **N.S** | | **N.S** |
| **T*S** | | | | |
| **treatment** | | **S1** | **S2** | **Mean T** |
| **T1** | | **7.36** | **7.17** | **7.27** |
| **T2** | | **7.39** | **7.20** | **7.29** |
| **T3** | | **7.44** | **7.26** | **7.35** |
| **T4** | | **7.40** | **7.22** | **7.31** |
| **$LSD_{T*S}$** | | **N.S** | **$LSD_T$** | **0.05** |
| **K*S** | | | | |
| **K** | | **S1** | **S2** | **Mena K** |
| **K1** | | **7.44** | **7.27** | **7.36** |
| **K2** | | **7.35** | **7.16** | **7.25** |
| **$LSD_{K*S}$** | | **N.S** | **$LSD_k$** | **0.04** |
| **S** | | | | |
| **S** | | **S1** | **S2** | |
| **S Mean** | | **7.40** | **7.21** | |
| **LSDs** | | **0.04** | | |

**Electrical conductivity (Ec)**

The results have been found that there was a significant effect of adding saline water on the electrical conductivity of the soil in unburned soils (M2). The S2 treatment reached an average 2.05 dS $m^{-1}$ while the S1 treatment was 1.47 dS $m^{-1}$, with an increase of 39.4%. The electrical conductivity ratio has been also affected in the burned soil (M1). The treatment S1 has been recorded 2.76 dS $m^{-1}$, while the S2 has been recorded 3.31 dS $m^{-1}$, with a decrease rate of 16.6% (Tables 6 and 7).

The potassium fertilizer addition has been indicated a decrease in the electrical conductivity value of the unburned soil (M2). The second level K2 gave an average of 1.54, while the first level K1 was 1.98 (Tables 6 and 7).

However, the addition of potassium fertilizer (M1) to the burned soil for the second level K2 has been recorded the lowest average, which amounted 2.92, compared to the first level. The K1 treatment was recorded the highest average, it was 3.16. Therefore, the effects of these additions

were found on the value of electrical conduction of the soil. It is also noted that potassium fertilizer reduced the negative impact of salt stress as a result of improving soil properties, holding nutrients, reducing salt stress and reducing electrical conductivity(Adil et al., 2012; Burhan & AL-Taey, 2018). The potassium fertilizer is working on the plant's tolerance to high salinity through its physiological role in the extent of the plant's adaptation to the surrounding environment(Johnson et al., 2022; Shabala & Pottosin, 2014). It has been also led to improve the electrical conductivity (Bhardwaj et al., 2014; Shultana et al., 2020).

Table (6) effect of salty irrigation water and potassium fertilizer on the electrical conductivity in unburned soil

| treatments | Potassium (K) kg/h | irrigation water $dSm^{-1}$ | | T*K |
|---|---|---|---|---|
| | | S1 | S2 | |
| T1 | K1 | 1.52 | 2.09 | 1.81 |
| | K2 | 1.07 | 1.75 | 1.41 |
| T2 | K1 | 1.61 | 2.15 | 1.88 |
| | K2 | 1.25 | 1.83 | 1.54 |
| T3 | K1 | 1.75 | 2.56 | 2.16 |
| | K2 | 1.43 | 1.92 | 1.68 |
| T4 | K1 | 1.76 | 1.37 | 2.06 |
| | K2 | 1.37 | 1.71 | 1.54 |
| $LSD_{T*K*S}$ | | 0.14 | | N.S |
| T*S | | | | |
| treatment | | S1 | S2 | Mean T |
| T1 | | 1.30 | 1.92 | 1.61 |
| T2 | | 1.43 | 1.99 | 1.71 |
| T3 | | 1.59 | 2.24 | 1.92 |
| T4 | | 1.57 | 2.04 | 1.80 |
| $LSD_{T*S}$ | | N.S | $LSD_T$ | 0.07 |
| K*S | | | | |
| K | | S1 | S2 | Mena K |
| K1 | | 1.66 | 2.29 | 1.98 |
| K2 | | 1.28 | 1.80 | 1.54 |
| $LSD_{K*S}$ | | 0.07 | $LSD_k$ | 0.05 |
| S | | | | |
| S | | S1 | S2 | |
| S Mean | | 1.47 | 2.05 | |
| LSDs | | 0.05 | | |

Table (7) effect of salty irrigation water and potassium fertilizer on the electrical conductivity in burned soil

| treatments | Potassium (K) kg/h | irrigation water $dSm^{-1}$ | | T*K |
|---|---|---|---|---|
| | | S1 | S2 | |
| T1 | K1 | 2.72 | 3.27 | 3.00 |
| | K2 | 2.55 | 3.07 | 2.81 |
| T2 | K1 | 2.86 | 3.31 | 3.09 |
| | K2 | 2.66 | 3.14 | 2.90 |
| T3 | K1 | 3.03 | 3.69 | 3.36 |
| | K2 | 2.76 | 3.24 | 3.00 |
| T4 | K1 | 2.90 | 2.61 | 3.18 |
| | K2 | 2.61 | 3.33 | 2.97 |
| $LSD_{T*K*S}$ | | N.S | | N.S |
| T*S | | | | |
| treatment | | S1 | S2 | Mean T |
| T1 | | 2.63 | 3.17 | 2.90 |
| T2 | | 2.76 | 3.22 | 2.99 |
| T3 | | 2.90 | 3.46 | 3.18 |
| T4 | | 2.75 | 3.40 | 3.08 |
| $LSD_{T*S}$ | | N.S | $LSD_T$ | 0.12 |
| K*S | | | | |
| K | | S1 | S2 | Mena K |
| K1 | | 2.88 | 3.43 | 3.16 |
| K2 | | 2.64 | 3.19 | 2.92 |
| $LSD_{K*S}$ | | N.S | $LSD_k$ | 0.09 |
| S | | | | |
| S | | S1 | S2 | |
| S Mean | | 2.76 | 3.31 | |
| LSDs | | 0.09 | | |

## Conclusion

The study has been concluded that unburned soil has been recorded highest values in some of the studied traits: plant height, grain yield, spike length, biological yield, number of branches, number of spikes, and content of elements including K, P, N. The results have been also found a response to potassium fertilization. The best level was the second level K2 250 kg. The potassium fertilizer plays a role to improve the pH soil. Therefore, the effects of these additions were found on the value of electrical conduction of the soil. It is also noted that potassium fertilizer reduced the

negative impact of salt stress as a result of improving soil properties, holding nutrients, reducing salt stress and reducing electrical conductivity.

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