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ORIGINAL ARTICLE

EFFECT OF IRRIGATION WATER TREATMENT AND NATURAL ZEOLITE ON SOME COMPONENTS CORN PLANT (*ZEA MAYS* L.) UNDER LEVELS OF PHOSPHATE FERTILIZATION IN CALCAREOUS SOILS

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Abstract: Two experiments were done, the first is laboratory to study the efficiency of chimney dust in water treatment and the second to know the effect of the levels of natural zeolite by using two soils of different textures and the effect of phosphate fertilizer levels on dry weight and the amount of nitrogen absorbed and their interaction in yellow maize plant *Zea mays* L. planted in the wooden canopy of the Department of Soil Sciences and Water Resources, College of Agriculture, University of Basra, during the agricultural season 2018, according to the Completely Randomized Design within a factorial experiment of three treatments and three replications. The results of the study showed that treating the studied water W1, W2, and W3 by chimney dust led to a decrease in water salinity with a decrease of (71.80, 70.03, 57.89)% compared with the non-treated treatments, which was positively reflected in the increase of the dry weight of the vegetative system with increased rates of 47.98% and 58.15% in sandy loam soils and 39.73% and 44.59% in loam clay soils for treatments Z1 and Z2 respectively, compared with treatment Z0, and the addition of phosphate fertilizers P1 and P2 had no significant effect on the average of the dry weight and in both turbines. There was a significant increase in the rate of the absorbed amount of nitrogen at rates (21.61, 24.02, 29.27 and 33.74)% for factors Z1 and Z2 compared with treatment Z0 for both soils, respectively with increase rates of (6.10, 12.20, 6.72 and 10.05)% for both soils, respectively. It was noted that the best level of zeolite and phosphate fertilizer is Z2 and P2.

***Key words*:** Chimney dust, Zeolite, Water salinity, Dry weight.

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1. Introduction

In recent decades, the world has witnessed a great shortage in the quantities of usable water, which made it a real challenge for specialists in finding successful means to prosess this problem. The percentage of saline water that is not suitable for agricultural consumption has reached more than 97%, making only 1% of fresh water suitable for consumption after deducting the percentage of groundwater. Even the International Water Management Institute has expected that one third of the world's population will live in areas where water is scarce by 2025 and there is no doubt that the areas of dry and semi-arid climates will be most affected by this shortage in addition to the high population growth in it.

The use of water treatment technologies such as reverse osmosis, ion exchange and membrane technologies to reduce mineral and toxic ions from polluted water is still economically costly, so researchers resorted to using less expensive and locally available options including the use of the chimney dust filter, which is similar in its behavior to calcium carbonate in reducing and precipitating elements [Alzubaidi (2021), Al-Amiri (2006), Wafaa *et al.* (2021)]. The ability of the chimney dust filter to reduce sodium, magnesium, potassium,

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Table 1: Elementary properties and ionic composition of the studied water.

Water Salinity	pH	EC dsi siemens.m^{-1}	Positive ions mg. L^{-1}				Negative ions amalgam. L^{-1}			TDS mg.l^{-1}	Hardness mg.l^{-1}
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	SO^{2-}	HCO^{3-}		
W_1	7.82	4.93	323.60	106.15	687.40	163.10	1212	872.66	3448.11	3181	1248
W_2	7.80	8.01	533.06	168.43	1268.81	35.51	1259	1663.23	1554.33	6236	2030
W_3	7.71	17.1	743.39	336.58	3574.00	385.60	3981	2210.00	1836.42	13480	3262

sulfate and nitrate ions. Zeolite (a hydrocrystalline aluminum silicate) is characterized by cation exchange capacity, high moisture retention capacity, adsorption capacity, and cation exchange capacity [Aliwi and Manea (2021)]. To increase the soil's water retention capacity, it is used in many fields such as industry, agriculture and water treatment. *Zea mays* L. is one of the most important cereal crops whose production is affected quantitatively and qualitatively by saline water. It is the most responsive field crop to fertilizers because of its important role in the growth and development stages of the plant being the substrate from which the plant derives nutrients, including phosphorous [Kadim *et al*. (2021)]. Therefore, this study aims to treat water and reuse it in irrigating maize plants, and to know the best level of zeolite and phosphate fertilizer in affecting plant growth vocabulary.

2. Materials and Methods

Water samples represented by W1 well water, W2 river water and W3 sewage water were collected and kept in plastic containers in the refrigerator. Some chemical and physical properties (Table 1) were estimated according to the methods described in AWPHA (2005).

Chimney dust was used, washed with plain water and distilled water, air dried and placed in plastic poles ending with a conical end attached to a valve to control the speed and quantity of water leaving it. Glass wool was placed in the valve nozzle to prevent chimney dust from entering the valve. The plastic poles were fixed on aluminum brackets to rest on them according to the method used by Liu *et al*. (2000).

The columns were covered with glass wool and 500 ml water was added to them separately after sealing the bottom plug and left for about two minutes after testing the efficiency of chimney dust in the

Table 2: Some chemical and physical properties of the two study soils.

The property		Al-Borjisiya soil	Aljazira soil
1:1 reaction degree (pH)		7.89	8.01
The electrical conductivity of decisiemens M^{-1}		3.8	5.3
Total solid carbonate g. kg^{-1}		123.00	350.00
Positive exchange capacity mEq/100g		18.00	24.00
Organic matter GM. kg^{-1}		0.70	4.30
Ready nitrogen mg. kg^{-1}		15.10	64.01
available phosphorous mg. kg^{-1}		3.40	32.60
Available potassium mg. kg^{-1}		16.15	86.40
positive ions Ml.mol. Liter $^{-1}$	Ca^{2+}	6.25	9.61
	Mg^{2+}	5.81	8.10
	Na^{+}	17.70	23.35
	K^{+}	0.52	1.44
Negative ions Ml.mol. Liter^{-1}	Cl^{-}	23.00	32.11
	SO_4^{2-}	6.92	10.21
	HCO_3^{-}	3.10	6.30
	CO_3^{2-}	0.00	0.00
Soil Separatorsgram. kg^{-1}	Clay	58.00	550.00
	silt	81.90	380.00
	sand	860.10	70.00
soil texture		sandy mix	Loam clay

Table 3: Some chemical properties of zeolite.

Ds.mM^{-1}	pH	Available mg.kg^{-1}			mEq/100 g
		N	P	K	
13.71	7.98	28.1	0.2	154	197.72

percentages of reducing the electrical conductivity of water through a series of time periods (1, 2, 3 and 5) minutes, where it proved the efficiency of two minutes in giving the highest percentage of reduction, then the water was collected in a plastic beaker and chemical analyzes were carried out. The process of passing water through the columns containing chimney dust was repeated with doubling the quantity and volume of water according to the treatments in order to obtain sufficient water for irrigation in the agricultural experiment. Soil samples were selected from two agricultural sites of different textures, one from the agricultural field of the Agricultural Research Station in Al-Barjisiya/General Authority for Agricultural Research/Ministry of Agriculture, and the other from one of the orchards in Al-Jazirah region. Some chemical and physical properties are estimated (Table 2) according to the methods described in Blak (1965) and Page *et al.* (1982). Soil samples were collected for each site from the surface layer (0-30 cm) and it was pneumatically dried, then sifted and sieved through a sieve with holes capacity of 2 mm and placed in plastic pots with a capacity of 4 kg, after placing a layer of gravel at the bottom of each pot and filled with 3 kg of soil, adding natural zeolite at a level of 0, 40 and 80 m.ha^{-1} (Table 3). An agricultural experiment was designed using it contained plant *Zea mays* L. The experiment was carried out in the wooden canopy of the College of Agriculture, University of Basra during the growing season 2018. *Zea mays* plant were planted in the above-mentioned pots on 1/3/2018 and were added fertilizers at levels 320 kg N ha^{-1} and in two batches, the first before planting, loam with the soil, and the second after 45 days of planting with irrigation water. Phosphate fertilizer was added at three levels (0, 60 and 120) kg P ha^{-1} and its symbols are P0, P1 and P2 and potassium fertilizer at a level of 120 kg K ha^{-1} and both fertilizers were added at once mixing with the soil. After the success of the germination process, it was diluted to 3 plants in each pot and the pots were irrigated during the experiment with the above-mentioned treated water as well as the comparison treatment. The complete randomized block design was followed within a factorial experiment of three factors and three replications.

After 60 days of planting, the plants were cut after leaving a distance of 2 cm from the surface of the soil and placed in paper bags and transferred directly to the laboratory and cleaned with a piece of gauze and distilled water and then dried in the oven at a temperature of 70°C until completely dry and the dry weight was taken and then crushed and shifted through a sieve the diameter of its holes (1 mm). The dry plant samples were digested using the method suggested by Cresser and Parsons (1979), then the nitrogen absorbed from the digestion solution was estimated using a steam distillation apparatus as described in Page *et al.* (1982).

3. Results and Discussion

3.1 Effect of flue dust filter in water treatment

The results of Table 4 showed that the treatment of the studied water W1, W2, and W3 with a chimney dust filter achieved a decrease in the values of positive and negative ions, which was positively reflected in reducing the values of the electrical conductivity with a decrease of (71.80, 70.03, 57.89,)% compared with the control treatment (Table 1). This is due to the fact that the chimney dust filter works with different mechanisms, one of which is that it is a medium with a high adsorption capacity and has a surface area that qualifies it to reduce the percentage of ions in the water [Al-Amiri (2006)].

There was also an increase in the pH values of the studied water after treatment and this is due to the formation of hydroxides such as calcium hydroxide, which leads to raising the pH values of the medium and this leads to the formation of a suitable medium to reduce the solubility of many compounds due to complex and diverse reactions, including adsorption and precipitation reactions [Shively *et al.* (1986)].

Table 4: Chemical properties and ionic composition of water after treatment.

Treated Water	pH	EC dsi siemens.m^{-1}	Positive ions mg. L^{-1}				Negative ions amalgam. L^{-1}			TDS mg.l^{-1}	Hardness mg.l^{-1}
			Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	SO^{2-}	HCO^{3-}		
W_1	7.82	1.39	116.23	20.04	170.00	81.92	301.71	336.00	93.70	691	373.0
W_2	7.80	2.40	205.31	48.14	375.50	13.91	378.11	471.00	433.00	1134	716.8
W_3	7.71	7.20	326.62	109.55	1251.77	200.00	1664.11	1786.00	710.51	5598	1272.0

Table 5: Effect of experimental treatments on the average dry weight of the vegetative system of *zea mays* (g.pot^{-1}) in sandy loam soil.

Treated water	Zeolite level	Phosphate fertilizer level			W × Z
		P_0	P_1	P_2	
W_1	Z_0	10.03	10.45	10.62	10.36
	Z_1	12.54	12.80	12.93	12.75
	Z_2	13.07	13.30	13.41	13.26
W_2	Z_0	6.33	6.51	6.62	6.48
	Z_1	9.11	9.36	9.60	9.45
	Z_2	9.24	9.51	9.80	9.51
W_3	Z_0	1.70	1.74	1.75	1.73
	Z_1	5.11	5.46	5.60	5.39
	Z_2	6.38	6.60	6.82	6.60

P / W	P_0	P_1	P_2	W Average
W_1	11.88	12.18	12.32	12.12
W_2	8.22	8.46	8.67	8.45
W_3	4.39	4.60	4.72	4.57
P Average	8.16	8.41	8.57	-

P / Z	P_0	P_1	P_2	Z Average
Z_0	6.02	6.23	6.33	6.19
Z_1	8.92	9.20	9.37	9.16
Z_2	9.56	9.80	10.01	9.79

W / Z	W_1	W_2	W_3	Z Average
Z_0	10.36	6.48	1.73	6.16
Z_1	12.75	9.35	5.39	9.16
Z_2	13.26	9.51	6.60	9.79

LSD	W	Z	P	W × Z	W × P	P × Z	W × Z × P
(0.05)	3.1	2.2	n.s	2.61	3.17	2.4	3.27

3.2 Effect of experimental treatments on the average dry weight of the vegetative system of zea mays (g. pot^{-1}) in sandy mixture

The results of Table 5 showed the effect of treated water, zeolite and phosphate fertilization and the interaction between them on the average dry weight of the vegetative system of zea mays (g.pot^{-1}) growing in sandy loam soil, as the results of the statistical analysis at the 0.05 level showed that the use of treated water in the vegetative system treatment Z0 led to the emergence of significant differences in the average dry weight of vegetative growth and the values were (12.12, 8.45, and 4.57) g.pot^{-1}, respectively, with a decrease of 30.28% and 62.29% for treatments W2 and W3, respectively compared to the control treatment in W1 [Supper (2003)] indicated that the increase in water salinity is reflected in the soil structure, water and air balance, and consequently on the biological activity in the soil and the effectiveness of the roots, which reduces the dry weight of the vegetative and root system.

The process of adding zeolite and using treated water led to a significant increase in the average dry weight of the vegetative system, reaching (6.19, 9.16, and 9.79) g.pot^{-1}, respectively, with an increase of 47.98% and 58.15% for the treatments (Z1 and Z2), respectively, compared with no treatment Z0. This is in agreement with Bates and Jackson (1977) and Ersin *et al*. (2004) that the use of zeolite improves the efficiency of water used by increasing the water holding capacity of the soil.

The addition of phosphate fertilizers did not have a significant effect on the average dry matter weight of the vegetative system, and the values were (8.16, 8.41 and 8.57 g.pot^{-1}). The interaction (P2 × W1) was superior and gave the highest rate of dry weight of the vegetative complex, which amounted to 12.32 g.pot^{-1}, while the interaction (P0 × W3) gave the lowest rate of dry weight, which amounted to 4.39 g.pot^{-1}. The interaction (Z2 × W1) showed the highest dry weight rate of 13.26 g.Pot^{-1} in the interaction (Z0 × W3) as for the triple interaction W in the treatments (P0 × Z0 × W1) and (P0 × Z0 × W2) and (P0 × Z0 × W3) in the average dry weight of the vegetative system, it was found significant and reached (10.03, 6.33 and 1.70) g.Pot^{-1}, respectively, with a decrease of 36.88% and 83.05% for the last interaction, respectively, compared to the treatment of no zeolite treatment and no addition of zeolite and fertilizer .

As for the effect of the levels of P addition in the interference (P0 × Z0 × W1) and (P1 × Z0 × W1) and (P2 × Z0 × W1) on the average dry weight of the vegetative part was not significant and the values were (10.03, 10.45 and 10.62). gram.pot^{-1} in a row and the other transactions followed the same direction.

The effect of treatment treatments Z in the interactions (P0 × Z0 × W1) and (P0 × Z1 × W1) and (P0 × Z2 × W1) on the average dry weight of the vegetative part was significant and the values were (10.03, 12.54 and 13.07) g.Pot^{-1}, respectively with an increase of 25.02% and 30.30% for the other interaction respectively and the other treatments in W2 and W3

Table 6: Effect of experimental treatments on the average dry weight of the vegetative system of *zea mays* (g.pot^{-1}) in loam clay soil.

Treated water	Zeolite level	Phosphate fertilizer level			W × Z
		P_0	P_1	P_2	
W_1	Z_0	13.56	14.12	14.32	14.00
	Z_1	14.64	15.70	15.90	15.41
	Z_2	14.78	15.89	16.00	15.55
W_2	Z_0	9.61	10.00	10.41	10.00
	Z_1	12.11	12.32	12.57	12.33
	Z_2	12.23	12.71	13.00	12.64
W_3	Z_0	3.11	3.20	3.26	3.19
	Z_1	9.85	10.31	10.56	10.24
	Z_2	10.77	11.00	11.55	11.10

P / W	P_0	P_1	P_2	W Average
W_1	14.32	15.23	15.40	14.98
W_2	11.31	11.67	11.99	11.65
W_3	7.91	8.17	8.45	8.17
P Average	11.18	11.69	11.94	-

P / Z	P_0	P_1	P_2	Z Average
Z_0	8.76	9.10	9.33	9.06
Z_1	12.20	12.77	13.01	12.66
Z_2	12.59	13.20	13.51	13.1

W / Z	W_1	W_2	W_3	Z Average
Z_0	14.00	10.00	3.19	9.06
Z_1	15.41	12.33	10.24	12.66
Z_2	15.55	12.64	11.10	13.1

LSD	W	Z	P	W × Z	W × P	P × Z	W × Z × P
(0.05)	2.34	2.03	n.s.	2.65	2.57	2.29	2.86

followed the same direction. The effect of the triple interaction of the treatments (P2 × Z2 × W2) and (P2 × Z2 × W3) on the average dry weight of the vegetative system was significant and amounted to (9.80 and 6.82) g.pot^{-1} with a decrease of 26.92% and 49.14%, respectively compared with Transaction (P2 × Z2 × W1), as for the effect of the experiment's treatments on the average dry weight of the vegetative system of zea mays (g.pot^{-1}) growing in silty clay soil (Table 6) the results of the statistical analysis at the level of 0.05 showed that water treatment and no addition of zeolite led to significant differences in the average dry weight of the vegetative group, and the values were (14.98, 11.65 and 8.17) g.pot^{-1}, respectively, with a decrease rate of 22.22% and 45.46% for W2 treatments and W3 respectively compared to the comparison treatment W1. The results of the current study agree with Phocaides (2001), that the increase in the salinity of irrigation water causes an accumulation of salts in the soil (cumulative effect, especially in the root zone) and thus may result in an increase in osmotic pressure, which reduces the availability of water, which is reflected on the production of dry matte. The process of water treatment and the addition of zeolite achieved a significant increase in the average dry weight of the vegetative system, and the values were (9.06, 12.66 and 13.1) g.pot^{-1}, respectively, with an increase of 39.73% and 44.59% for treatments Z1 and Z2 respectively compared with no treatment. Z0, and this is due to the role of zeolite, which has a silicate skeletal structuer with Open bonding sites for bonding with ions of other compounds in the form of channels occupied by water molecules. The addition of phosphorous fertilizers did not have a significant effect on the average dry matter weight of the vegetative system, and the values were (11.18, 11.69 and 11.94) g.pot^{-1}. The interaction (W1 × P2) was superior and gave the highest average dry weight of the vegetative complex, reaching 15.40 g.pot^{-1}, while the interaction (W3 × P0) gave the lowest dry weight rate, which amounted to 7.91 g.pot^{-1}. The interaction (W1 × Z2) showed the highest dry weight rate as it reached 15.55 gm.pot^{-1} and the lowest dry weight rate was 3.19 gm.pot^{-1} in the interaction (W3 × Z0).

As for the effect of the triple interference W in the treatments (P0 × Z0 × W1) and (P0 × Z0 × W2) and (P0 × Z0 × W3) on the average dry weight of the vegetative part, it was found significant and it reached (13.56, 9.61 and 3.11) g^{-1}, respectively, with a decrease of 29.12% and 77.06% for the other interaction, respectively, compared to the no addition treatment.

As for the effect of the levels of P addition in the interference (P0 × Z0 × W1) and (P1 × Z0 × W1) and (P2 × Z0 × W1) on the average dry weight of the vegetative system was significant and the values were (13.56, 14.12 and 14.32) g.pot^{-1}, respectively, with an increase of 4.12% and 5.60% for the other interactions, respectively, and the other transactions followed the same direction.

The effect of Z coefficients in the interactions (P0 × Z0 × W1) and (P0 × Z1 × W1) and (P0 × Z2 × W1) on the average dry weight of the vegetative part was significant and the values were (13.56, 14.64 and 14.78) g.$^{-1}$, respectively, with an increase of 7.96% and 8.99%

Table 7: Effect of experimental treatments on the average nitrogen uptake (gm. kg^{-1}) of *zea mays* in sandy loam soil.

Treated water	Zeolite level	Phosphate fertilizer level			W × Z
		P_0	P_1	P_2	
W_1	Z_0	15.00	17.27	18.20	16.82
	Z_1	18.86	19.20	20.08	19.38
	Z_2	19.18	19.41	20.10	19.56
W_2	Z_0	12.22	13.15	14.12	13.16
	Z_1	14.51	15.45	16.70	15.55
	Z_2	14.47	15.60	17.14	15.90
W_3	Z_0	9.15	10.11	10.39	9.88
	Z_1	12.84	13.43	14.31	13.52
	Z_2	13.09	14.17	14.60	13.95

P / W	P_0	P_1	P_2	W Average
W_1	17.68	18.62	19.46	18.58
W_2	13.90	14.73	15.98	14.87
W_3	11.69	12.57	13.1	12.45
P Average	14.42	15.30	16.18	-

P / Z	P_0	P_1	P_2	Z Average
Z_0	12.12	13.51	14.23	13.28
Z_1	15.40	16.02	17.03	16.15
Z_2	15.74	16.39	17.28	16.47

W / Z	W_1	W_2	W_3	Z Average
Z_0	16.82	13.16	9.88	13.28
Z_1	19.38	15.55	13.52	16.15
Z_2	19.56	15.90	13.95	16.47

LSD	W	Z	P	W × Z	W × P	P × Z	W × Z × P
(0.05)	2.53	2.41	1.21	2.97	2.84	2.60	3.11

for the other interference, respectively, and the other coefficients in W2 and W3 followed the same direction.

The effect of the triple interaction of the treatments (P2 × Z2 × W2) and (P0 × Z2 × W3) on the average dry weight of the vegetative system was significant and amounted to (13.00 and 11.55) g.pot^{-1} with a decrease of 18.75% and 27.81%, respectively, compared with Transaction (P2 × Z2 × W1). It was noted that the highest average dry weight of the vegetative system appeared in the interaction (P2 × Z2 × W1) and it amounted to 16.00 g.pot^{-1} and the lowest rate in the interaction (P0 × Z2 × W3) which was 3.11 g.pot^{-1}.

The results of Tables 5 and 6 showed the superiority of loam clay soils with a significant difference at the level of 0.05 in the average dry matter compared to sandy loam soils. The reason for this may be due to the difference in soil properties, which is related to the high regulatory capacity of clay soils in gradually supplying the plant with the required elements over the life of the plant compared to sandy loam soil.

3.3 Effect of experimental treatments on the amount of nitrogen absorbed (g. kg^{-1}) of *zea mays*

The results of Table 7 showed the effect of treated water, zeolite addition and phosphate fertilization and the interaction between them on the amount of nitrogen absorbed by zea mays grown in sandy loam soil. The results of the statistical analysis at the 0.05 level showed that using treated water and not adding Z0 zeolite led to significant differences in the rate of the absorbed amount of nitrogen, and the values reached (18.58, 14.87 and 12.45) g N kg^{-1} dry matter, respectively, with a decrease of 19.96% and 32.99% for treatments W2 and W3, respectively compared to comparison treatment W1. This study agrees with the findings of Karimi *et al*. (2005) that the use of saline water leads to a deficiency in the absorption of nutrients in the plant.

The treatment process and the addition of zeolite led to a significant increase in the rate of the absorbed amount of nitrogen, as the values reached (13.28, 16.15 and 16.47) g N kg^{-1} dry matter, respectively, with an increase of 21.61% and 24.02% for treatments Z1 and Z2, respectively. Compared with treatment Z0, the results showed a significant increase in the rate of the absorbed amount of nitrogen with the increase in the levels of phosphate fertilizer, and the values reached (14.42, 15.30 and 16.18) g N kg^{-1} dry matter, respectively, with an increase of 6.10% and 12.20%. This is attributed to the role of zeolite, which plays the role of a slow release of nutrients from fertilizers and improves fertilizer efficiency.

The interaction (W1 × P2) was superior and gave the highest rate of the absorbed amount of nitrogen, which amounted to 19.46 g N kg^{-1} dry matter, while the interference (W3 × P0) gave the lowest rate of the absorbed amount, which amounted to 11.69 g N kg^{-1} dry matter, and the interaction (W1 × Z2) showed that the highest rate of absorbed quantity was 19.56 g N kg^{-1} dry matter, and the lowest rate of interference (W3 × Z0) was 9.88 g N kg^{-1} dry matter

The interaction (W1 × P2) was superior and gave the highest average of the absorbed amount of nitrogen,

Table 8: Effect of the experimental parameters on the average amount of nitrogen absorbed (g. kg^{-1}) of maize plants in loam clay soil.

Treated water	Zeolite level	Phosphate fertilizer level			W × Z
		P_0	P_1	P_2	
W_1	Z_0	18.13	19.00	20.11	19.08
	Z_1	20.67	22.47	23.50	22.21
	Z_2	21.00	23.16	23.83	22.66
W_2	Z_0	15.37	16.41	17.00	16.26
	Z_1	19.49	21.14	21.87	20.83
	Z_2	20.15	21.66	22.00	21.27
W_3	Z_0	10.80	11.00	11.22	11.00
	Z_1	16.22	17.16	17.22	16.86
	Z_2	17.50	18.04	18.60	18.04

P / W	P_0	P_1	P_2	W Average
W_1	19.93	21.45	22.48	21.31
W_2	18.33	19.73	20.29	19.45
W_3	14.84	15.40	15.68	15.30
P Average	17.70	18.89	19.48	-

P / Z	P_0	P_1	P_2	Z Average
Z_0	14.76	15.47	16.11	15.44
Z_1	18.79	20.25	20.86	19.96
Z_2	19.55	20.95	21.47	20.65

W / Z	W_1	W_2	W_3	Z Average
Z_0	19.08	16.26	11.00	15.44
Z_1	22.21	20.83	16.86	19.96
Z_2	22.66	21.27	18.04	20.65

LSD	W	Z	P	W × Z	W × P	P × Z	W × Z × P
(0.05)	3.40	2.71	1.20	3.63	3.51	2.82	3.76

which amounted to 19.46 g N kg^{-1} dry matter, while the interaction (W3 × P0) gave the lowest rate of the absorbed amount, reaching 11.69 g N kg^{-1} dry matter, and the interaction (W1 × Z2) showed that the highest rate of absorbed amount was 19.56 g N kg^{-1} dry matter, and the lowest rate was in the interference (W3 × Z0), which was 9.88 g N kg^{-1} dry matter.

As for the effect of the triple interference W in the treatments (P0 × Z0 × W1) and (P0 × Z0 × W2) and (P0 × Z0 × W3) on the rate of the absorbed quantity, it was found significant and it reached (15.00, 12.22 and 9.15) g N kg^{-1} dry matter, respectively, with a decrease of 18.53% and 39% for the other interaction, respectively, compared with the W1 treatment and no zeolite was added and no fertilizer was added.

As for the effect of the levels of P addition in the interference (P0 × Z0 × W1) and (P1 × Z0 × W1) and (P2 × Z0 × W1) on the average amount of nitrogen absorbed, the values were (15.00, 17.27 and 18.20) g N kg^{-1} dry matter in a row and the other treatments proceeded in the same direction.

The effect of treatment coefficients Z in the interactions (P0 × Z0 × W1) and (P0 × Z1 × W1) and (P0 × Z2 × W1) on the rate of the absorbed amount was significant and the values were (15.00, 18.86 and 19.18) g N kg^{-1} dry matter, respectively, with an increase of 25.73% and 27.86% for the other interaction, respectively, compared with the no-manure treatment, and the other treatments in W2 and W3 followed the same direction.

The effect of the triple interaction of the treatments (P2 × Z2 × W2) and (P2 × Z2 × W3) on the rate of the absorbed amount was significant and amounted to (17.14 and 14.60) g N kg^{-1} of dry matter, with a decrease of 14.72% and 27.36%, respectively, compared with Transaction (P2 × Z2 × W1)

As for the effect of the experimental parameters on the average amount of nitrogen absorbed (gm N kg^{-1} dry matter) of zea mays grown in loam clay soil (Table 8). The results of the statistical analysis at the 0.05 level showed that water treatment and no addition of zeolite led to significant differences in the rate of the absorbed amount, as the values reached (21.31, 19.45 and 15.30) g N kg^{-1} dry matter, respectively, with a decrease of 8.72% and 28.20% for W2 treatments and W3, respectively compared to the comparison treatment

The process of water treatment and addition of zeolite led to a significant increase in the rate of the absorbed amount of nitrogen, as the values reached (15.44, 19.96, and 20.65) g N kg^{-1} dry matter, with an increase of 29.27% and 33.74% for treatments Z1 and Z2, respectively compared with no treatment Z0. The results showed a significant increase in the rate of the absorbed amount of nitrogen with the increase in the levels of phosphate fertilizer, and the values reached (17.70, 18.89 and 19.48) g Nkg^{-1} dry matter, respectively, with an increase of 6.72% and 10.05%

The interaction (W1 × P2) outperformed and gave the highest rate of the absorbed amount of nitrogen, which amounted to 22.48 g N kg^{-1} dry matter, while the interference (W3 × P0) gave the lowest rate, which amounted to 14.84 g N kg^{-1} dry matter, and the interference showed (W1 × Z2). The highest rate of the absorbed quantity was 22.66 gm N kg^{-1} dry matter, and the lowest rate was in the interference (W3 × Z0), which was 11.00 gm N kg^{-1} dry matter.

As for the effect of the triple interference W in the treatments (P0 × Z0 × W1) and (P0 × Z0 × W2) and (P0 × Z0 × W3) on the rate of the absorbed quantity, it was significant and the values reached (18.13, 15.37 and 10.80) g N kg^{-1} dry matter, respectively, with a decrease of 15.22% and 40.43% for the other interference, respectively.

The effect of the levels of P addition in the interference (P0 × Z0 × W1) and (P1 × Z0 × W1) and (P2 × Z0 × W1) on the rate of the absorbed amount was significant and the values were (18.13, 19.00 and 20.11) g N kg^{-1}, dry matter straight and other treatments proceeded in the same direction.

As for the effect of treatment coefficients Z in the interactions (P0 × Z0 × W1) and (P0 × Z1 × W1) and (P0 × Z2 × W1) on the rate of the absorbed quantity, it was significant and the values reached (18.13, 20.67 and 21.00) g N kg^{-1} dry matter, respectively, with an increase of 14.00% and 29.5% for the other interactions, respectively, compared to the treatment of no manure, and the other treatments in W2 and W3 followed the same direction.

The effect of the triple interaction of the treatments (P2 × Z2 × W2) and (P0 × Z2 × W3) on the rate of the absorbed amount was significant and reached (22.00 and 18.60) g N kg^{-1} dry matter with a decrease of 7.67% and 21.94%, respectively, compared with Transaction (P2 × Z2 × W1).

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