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Effect Of Natural Zeolite, Humic Acid And Cow Manure Treatments On Phosphorous Speed Release And Availability In Sandy Soils

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Abstract

A laboratory experiment was conducted at the University of Kufa, College of Agriculture/ Department of Soil and Water Sciences, to study the effect of natural zeolite, humic acid and cow manure on the speed of phosphorous release in sandy soils. The experiment included the use of plastic pots with a size of 1/2 kg and sandy soil mixed from the Fadak desert farm belonging to Ali's holy shrine investment. The treatments were natural zeolite 1.5 g/pot, humic acid 4.5 ml/pot, or cow waste 9.42 g/pot with 30 anvils for each treatment. In addition to the control treatment, with 120 total pots. The treatments were randomly distributed according to (RCBD) and the speed of phosphorous release was calculated after an incubation period of (120, 60, 30, 15.1 hours) at different temperatures 20, 30 or 40 C°. The results showed that the addition of natural zeolite led to raising the values of the interaction degree of sandy soil from (7.73 to 8.13), reducing the EC of sandy soil from 49.3 to 41.5 decimens m-1. On the other hand, the highest rate of ready phosphorus in sandy soils was (43.37) mg kg-1 in the treatment of Natural zeolite after an incubation period of 1 hour at 40 C°, compared to the other highest values of 30.77 mg kg-1 in the treatment of humic acid after the same incubation period at the same temperature, and 27 mg kg- 1 in the treatment of cow manure after 1-hour incubation at 20 C°.

Keyword: Humic acid, minerals, soil properties, zeolite, organic fertilizer

INTRODUCTION

There are many studies related to phosphorous in soil, but the movement and washing of phosphorous from soil are few, especially in limestone soils. as most studies indicated that phosphorus is subject to fixation or deposition with the possibility of exposure to very small amounts of washing. These were studied in particular under conditions of very high rainfall, which did not agree with studies on the movement and washing of phosphorous in reclaimed soils with little rainfall, especially in Iraqi soils. Subsequent studies showed the presence of phosphorous movement in various forms, as phosphorous can move in a form called particulate P. (non-ionic), and this includes phosphorus associated with iron oxides, aluminum, manganese, carbonate minerals, organic phosphorous and (dicalcium phosphate), and adsorbed phosphorus According to the different mineral images (Sharple et al., 1991; Al Qaisi et al., 2001; Dehghan et al., 2008).

Zeolite is one of the geological layers of the earth, which was discovered by the Swedish geologist AFCronsted in 1756. It is widely used in the field of agriculture as one of the important minerals in this field. Zeolite improves the physical, chemical and fertility properties of the soil through many of its properties that help in reducing nutrients and providing a high moisture content to the plant in the soil environment. Humic acid, on the other hand, has an important effect in determining the properties of organic matter and its physical and chemical effects in the soil. The addition of humic acid to limestone soils with a high pH improves the processing of phosphorous by chelating the calcium ion and preventing the phosphate from the reaction that leads to the formation of calcium phosphate.

Humic acid has an effect on the aggregates of soil particles through the binding of negatively charged carboxylic or phenolic groups to the edges of positively charged clay particles. This process facilitates easy penetration of roots into the soil and increases the water holding capacity of the soil. In general, soils with a high content of humic have less nitrate leaching problem, thus increasing the efficiency of fertilizer use, and this is one of the goals of organic farming and reducing the quantities of chemical fertilizers added. Therefore, the study aimed to evaluate the effect of zeolite, humic acid and cow manure treatments on the availability of phosphorous in soil, effect of zeolites on the chemical properties of soil. And study the kinetics of phosphorous by applying kinetic equations to clarify the movement of phosphorous in the soil.

MATERILAS AND METHODS

Laboratory experiments were carried out in the Chemistry Laboratory, Department of Soil and Water Sciences \ Kufa University \ College of Agriculture on 9/10/2020 in 1/2 kg plastic pots. Sandy soil was used, taken from a depth of (30-0) cm, taken from the soil of Fadak Farm/Ataba Al-Alawiya in Najaf Governorate. The soil was pneumatically dried and passed through a 4 mm diameter sieve. A 0.5 Kg of dry soil was placed in each pot. Representative soil samples were taken, crushed and passed through a 2 mm pore sieve for estimating some physical and chemical properties of the study soil (Table 1). treatments were natural zeolite 1.5 g/pot, humic acid 4.5 ml/pot, or cow waste 9.42 g/pot with 30 anvils for each treatment. In addition to the control treatment, with 120 total pots. The treatments were randomly distributed according to (RCBD) and the speed of phosphorous release was calculated after an incubation period of (120, 60, 30, 15.1 hours) at different temperatures 20, 30 or 40 C°.

Table 1. Some physical and chemical properties of the soil used in the study

Properties	sandy soils	clay soils	Unit
EC	2.36	4.56	ds m^{-1}
pH	7.5	8.1	
Calcium	2.36	4.59	$mm.L^{-1}$
magnesium	1.58	3.26	

Sodium	1.82	4.65	
potassium	0.98	1.25	
sulfate	3.65	4.36	
chlorides	2.36	4.11	
bicarbonate	0.25	0.78	
available phosphorous	12.3	33.5	
total phosphorous	189.3	255.5	$Mg.Kg^{-1}$
Organic matter	9.65	12.34	$g.Kg^{-1}$
cation exchange capacity	22	45	cmolc/100g
soil texture	Sandy	Clay	
Clay	50	350	
silt	70	490	$g.Kg^{-1}$
sand	880	160	

The experimental measurements

The study included the measurement of ready-made phosphorous according to the Olsen method, after the phosphorus was extracted by 0.5M sodium bicarbonate (NaHCO3), and the color was developed with ammonium molybdate and ascorbic acid. The estimation was carried out using a spectrophotometer (Page et al., 1982). The Total phosphorous was also estimated by ammonium molybdate and ascorbic acid using a spectrophotometer at a wavelength of 882 nm as stated in Page et al. (1982). While The temperature was measured using a Thermo-Hygrometer.

Kinematics equations to describe liberated phosphorous

To calculate the amount of phosphorous liberated from soils and to find the best equation describing the mechanism of phosphorous liberation, and to find out the velocity coefficient of phosphorous liberation, KMg, kinetic equations were used (Sparks, 1985 a, b)

Zero order equation

$$C_0 - C_t = C_0 - K_d t \quad ......(1)$$

First order equation

$$Ln(C_0 - C_t) = LnC_0 - K_d t \quad ..... (2)$$

Parabolic diffusion equation

$$C_t / C_0 = C_0 + K_d \sqrt{t} \quad ....(3)$$

$$C_t = C_0 + K_d \text{ Int} \quad .... (4)$$

Data were analyzed according to analysis of variance (ANOVA) using the Genstat 2012 program, and means were compared for significant differences among treatments based on least significant difference L.S.D. at probability level of 0.05 (Al-Sahoki and Waheeb, 1990).

RESULTS AND DISCUSSION

Effect of treatments on the speed of releasing ready phosphorus (mg-1 kg) in sandy soils

The results showed a clear effect of treatments interaction with incubation period and temperature, which led to significant differences in the speed of phosphorous release in the sandy soil under study (Table 2). Zeolite treatment led to the highest rate of ready phosphorous concentration in sandy soil (43.37) mg kg-1 after an incubation period of 1 hour at 40 C, and a clear difference from the rest of the treatments, while the lowest value recorded in the control treatment, 15 hours of incubation at 30 C, which was 5.20 mg.kg-1. This is due to the fact that zeolite mineral has unique physical, chemical and mechanical properties, and has a high cationic exchange capacity, so it improves the chemical and physical properties of different soils, especially sandy soils. Therefore, Ranimi, Kavoosi (2000) indicated that mixing zeolite and chemical fertilizers with the soil raised the values of ready phosphorus in

Incubation period (Hours)	Incubation temperature (C°)	Treatments			
		Control	**Ziolite**	Humic acid	Cow manure
1	**20**	24.70	35.67	30.77	27.00
	30	20.03	31.77	25.00	21.50
	40	24.70	43.37	28.47	27.73
15	**20**	6.40	18.57	16.03	15.03
	30	5.20	12.50	6.50	14.77
	40	6.40	11.23	7.43	15.47
30	**20**	12.40	21.17	18.23	20.37
	30	10.43	17.30	13.43	17.03
	40	12.87	22.53	14.93	20.93
60	**20**	14.67	23.77	20.50	22.27

	30	11.87	19.63	15.20	18.60
	40	14.67	25.70	16.97	24.20
120	**20**	16.47	17.10	14.73	20.53
	30	13.33	19.33	16.67	14.50
	40	16.47	28.87	19.07	21.07
Average		**14.04**	**23.23**	**17.60**	**20.07**
L.S.D. ($P \leq 0.05$) interaction= 5.96					

Table2. Effect of treatments on the speed of releasing ready phosphorus (mg-1 kg) in sandy soils

sandy soil and improved soil fertility and increased its ability to retain nutrients. On the other hand, it is noted that humic acid and organic matter (cow waste) significantly increased the concentration of ready phosphorus in the soil after 1 hour incubation at 20 degrees with values of 30.77 mg kg-1 and 27.00 mg kg-1 with a significant difference from the control treatment, respectively.

Al-Husseini (2010) also indicated that the amount of ready phosphorous is directly proportional to the amount of organic matter present in the soil, and attributed this to the fact that the decomposition of organic matter in the soil increases the soil content of ready phosphorous. In another study, it was found that the addition of organic matter to the soil led to an increase in the amount of ready phosphorus in the soil because the organic matter contained sufficient quantities of ready phosphorus, as well as the mineralization of organic phosphorus and its transformation into mineral phosphorus ready for the plant during the decomposition process (Prism, 2006).

Effect of treatments on total phosphorous concentration (mg-kg-1) in sandy soils

As for the rate of total phosphorous concentration, it was also affected by the different treatments and the interaction with the incubation period and temperature (Table 3). The zeolite treatment recorded the highest phosphorous concentration in the soil (244.57) mg kg-1 among treatments after 1 hour incubation at 30C°, followed by humic (189.83 mg kg-1) after incubation 60 hours at 30C° and cow manure treatment at a rate of 220.33 mg kg 1 - after 15 h at the same temperature, compared to the control treatment, which led to 36.33 mg kg-1 after 120 h incubation at 40C °. This is consistent with the results of He et al. (2002) when mixing zeolite mineral with sandy soils led to an increase in the surface area and cat ion exchange capacity, It reduces nitrogen and phosphorous lost by leaching, and improves the physical and chemical properties of soils. Therefore, zeolite has an effective effect in sandy soils where nutrients and water are exposed to severe leaching, when adding minerals to these soils increases the ability of soil retention.

Table3. Effect of treatments on total phosphorous concentration (mg.kg^{-1}) in sandy soils

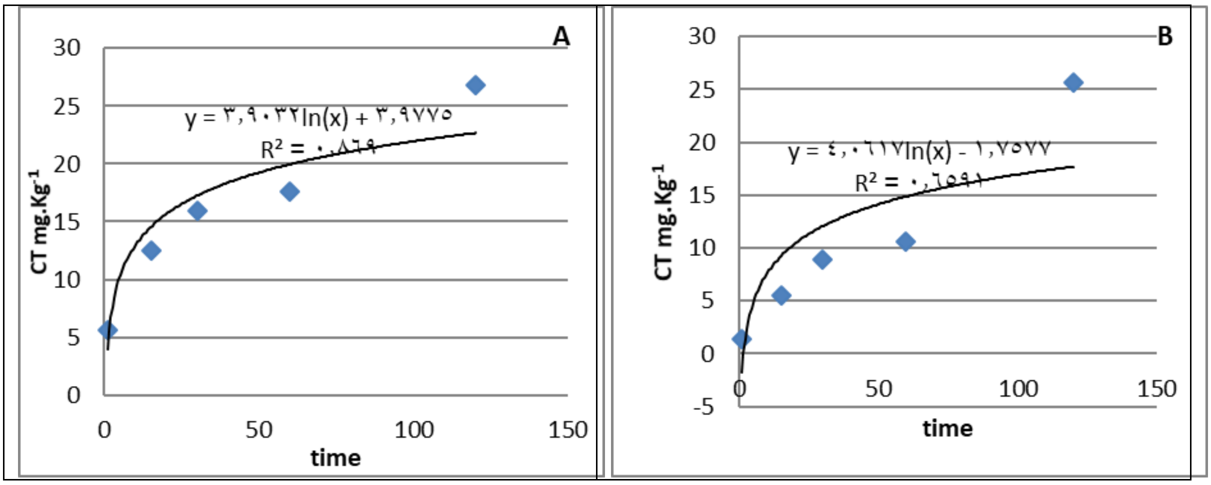
Incubation period (Hours)	Incubation temperature (C°)	Treatments			
		Control	**Ziolite**	Humic acid	Cow manure
1	**20**	133.90	210.10	141.33	183.03
	30	98.87	244.57	165.47	208.83
	40	84.93	192.00	144.80	187.07
15	**20**	74.50	172.43	103.87	103.87
	30	55.00	200.70	121.60	220.83
	40	47.23	157.53	138.17	197.87
30	**20**	103.07	190.57	121.90	197.97
	30	67.13	221.83	142.73	203.73
	40	65.37	174.13	124.87	182.53
60	**20**	112.73	196.63	127.93	172.23
	30	83.23	228.93	189.83	200.37
	40	71.20	179.70	131.10	179.53
120	**20**	103.47	190.80	122.13	127.77
	30	73.47	222.13	143.03	189.83
	40	36.33	180.37	125.13	170.10
Average		**81.30**	**197.50**	**133.60**	**181.70**
L.S.D. ($P \leq 0.05$) interaction= 38.25					

Ohno et al. (2005) confirmed that the decomposition of soil organic matter by microorganisms leads to an increase in dissolved organic carbon and this leads to a decrease in the amount of phosphorous adsorbed in the soil. There is a highly significant positive relationship between the concentration of dissolved organic carbon and the concentration of dissolved phosphorous in the soil solution. The addition of organic waste leads to an increase in the availability of vital phosphorous resulting from the proliferation and decomposition of microorganisms in the soil. Here, the dissolved organic carbon increases, which appears positively on the increase in the availability of phosphorous in the soil.

The results showed that the diffusion equation was the best in describing the release of phosphorous, especially for the zeolite treatment, which recorded the highest value of the theoretical correlation coefficient (r) which was 989.0 and the standard error (SE) of 301.0 in soil to describe the diffusion of phosphorous from the solid phase to the solution, and this is due to The natural zeolite has an important effect in increasing the movement of phosphorous.

Humic acid comes second with a correlation coefficient of 940. 0 and a standard error of 229. 0 in sandy soils in the effect of quickly releasing the phosphorous ion and reducing the time of liberation. This is due to the hydrogen ion and the speed of its disintegration in the soil to give hydrogen ions in the soil and thus ion exchange with the ions, including the phosphorous ion, liberating it from the solid phase to the liquid phase, and then increasing the readiness of phosphorus to the plant.

As for the treatment of organic matter in sandy soils, the values of the correlation coefficient were 869.0, and the standard error was 144. 0 less than the treatment of zeolite and humic acid. But the effect of the presence of organic matter in reducing the time of liberation of phosphorous. This is due to the fact that the liberation time needs a longer time in the organic matter in terms of interaction to form humic acid and humene, and then its effect on the liberation process. The comparison treatment in sandy soils recorded the lowest values in the correlation coefficient, which amounted to 871.0, and the standard error, which amounted to 0,331, and this is due to the absence of an effect other than the chemical reactions that occur with water in affecting the speed of phosphorous ion release.



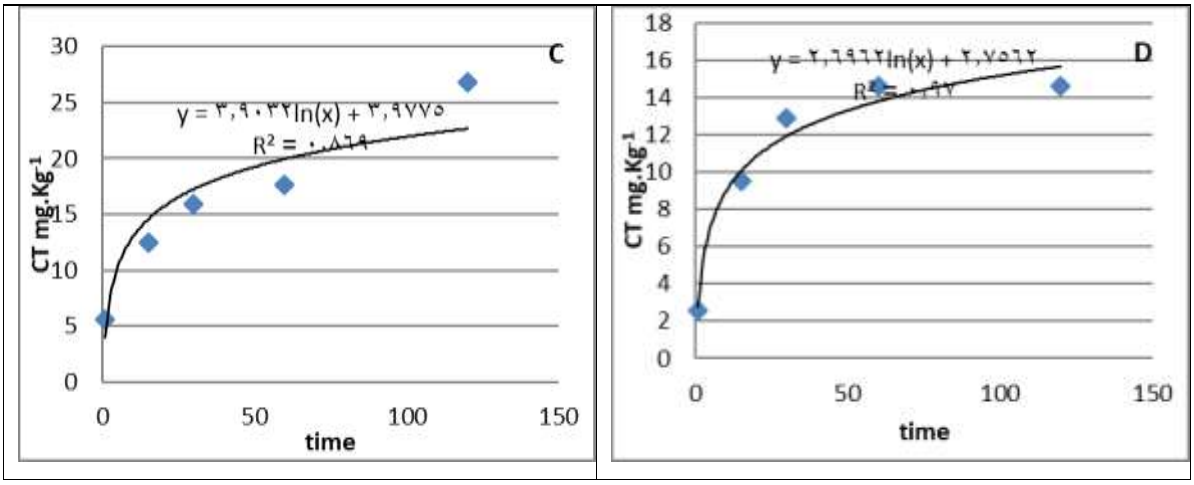


Figure1.The relationship between the kinetics of phosphorous cat ion CT and time t of diffusion equation in the control treatment (A), zeolite (B), humic acid (C), and cow manure (D)

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