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Effect of Sewage Wastes on Chemical Properties of Soil

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Abstract: *A field, experiment to study the effect of different levels of sludge on some chemical properties of soil., using The Randomized Complete Block Design (RCBD) with three replicates. We used four levels of sludge, which are (0, 40, 60, 80 ton ha*$^{-1}$*) and they symbolized respectively (S0,S1,S2,S3,and S4), respectively, and nitrogen fertilizer used from two nitrogen sources and three levels, namely urea and ammonium sulfate., The two were mixed, cultivated the seeds of yellow corn in hybrid cultivars as botanical evidence. It took soil samples after harvesting for the required analyzes. The results showed a significant increase in the electrical conductivity (EC), values for all levels of sludge addition (0,40,60,80), where the values reached (4.22, 5.28, 5.59, 5.92) dSm* $^{-1}$ *respectively, while mineral fertilization gave an increase. not significant in electrical conductivity values, There was a decrease in of soil reaction (pH) from (7.55) to (7.30) with an increase in, the levels of addition of sludge and also there was a significant increase in the concentrations of nutrients in the soil, where the nitrogen concentration increased from (373.1 -604.2) mg kg*$^{-1}$*Respectively, the component phosphorus increased from (7.6 to 21.2) mg kg*$^{-1}$*respectively, with of a decrease in the concentration of potassium in the soil from (315.7 to 247.5) mgKg*$^{-1}$ *with an increase in the levels, of addition of sludge, the results also show that there was a significant increase in the percentage of organic matter in the soil and for all levels of addition compared with the control treatment, where the increase ranged between (11.3 -18.7) g kg*$^{-1}$*.*

Keywords: *sewage waste ; sludge; soil chemical traits*.

1. INTRODUCTION

The Sewage sludge waste defined according to the standard specifications for the use of Sewage sludge in Iraq a mixture of solid, organic and inorganic materials and treated by aerobic and anaerobic fermentation and water removal from it,[1] where the sludge is considered one of the important environmental problems due to its negative impact on life, where the disposal process has become Including traditional methods such as burning and Bad landfill, as these wastes cause pollution to the soil and plants[2]. [3] found that adding sewage sludge to the soil leads to availability of some elements in the soil, adding that the sludge is a good and effective alternative to mineral fertilizers in order to improve soil fertility and also reduce costs associated with soil management and crop fertilization. Using sewage wastes

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in agriculture is one of the safe methods to get rid of them with less harm, as these wastes can give an increase in crop productivity and good economic return, and also reduce the costs of using mineral fertilizers because they are low in costs compared to mineral fertilizers [4]. [5] explained that the use of sewage sludge in agriculture is not a modern matter, due to the that of importance of the sludge in supplying the soil and plants with organic matter and nutrients, nitrogen and phosphorous. [6] showed that there was a significant increase in the electrical conductivity values when increasing the levels of addition of sewage waste, and this was) explained by of salts in sewage waste. [7]showed that there is a significant increase in the values of electrical conductivity of the soil with an increase in the levels of addition of sewage waste. High electrical conductivity with an increase in the level of sludge addition. [8] showed that addition of soil sludge led to changes in some soil traits as the electrical conductivity increased from 1.33 to 1.53-2.64 -3.21 when adding several levels of sludge,. (20-40-60 tons.ha^{-1})And [9] showed] that there was a significant increase in electrical conductivity when adding sludge to the soil, as the conductivity increased from 3.80 to 4.16 dSm $^{-1}$. it explained the reason for the increase in the percentage of salts in the added sludge. It was found [10] and [11] that sewage wastes and adding them to the soil at the level of (90 ton.ha^{-1}) have an important role in reducing soil reaction and the reduction ratio is (0.66 to 0.55) when compared with plant wastes and the reason for this is due to the fact that outputs of acidic sewage wastes and the effectiveness of Microbiology in the soil and [12] showed in a study on sewage sludge, showing that there is a decrease in the values of soil interaction with an increase in the levels of added sludge (25.50. 0.9, 1.4,2.1, 3.7%), and attributed the reason for this to the role of waste products in reducing the pH. (9.14) confirmed that sewage sludge led to a decrease in the values of of soil reaction, as it is preferred to use it in the base soils. The value of soil reaction degree (pH) decreased after using the sewage sludge and adding it to the soil. [13, 14, 15] showed that sewage wastes work to increase the organic matter clearly, which increases the effectiveness of micro-organisms in the soil, and these organisms work on the decomposition of organic matter and thus lead to an increase in humus in the soil. Sewage sludge depends on its content of nutrients and organic matter. The dry and humid climate leads to mineralization and the lack of organic matter. Because of the dry climate, soil bacteria decompose more quickly at high temperatures. In addition, some wrong agricultural practices lead to deterioration and a lack of organic matter in it. Adding sewage sludge to degraded soil improves the properties of this soil and increases its fertility. The problem of disposal of sewage sludge has become a great and important challenge due to the tremendous increase in population numbers and cultural and economic diversity, the sludge can be used as an organic fertilizer for the soil because it contains nutrients and organic matter that have a positive effect on the soil and plants [16. 17, 18 , 19] showed that the use of sewage sludge in agriculture is for the purpose of supplying the soil and plants with the nutrients needed for plant growth. Many studies have shown that due to the good properties and characteristics of sewage sludge, it can be used as a reclaimer and improver for degraded soils poor in nutrients and also used as fertilizer for agricultural crops because they contain important nutrients as they contain nitrogen in the first place, followed by phosphorus. The sludge after adding it to the soil leads to an increase in the availability of the concentrations of some basic nutrients such as nitrogen and available phosphorous and works to increase the yield and this is one of trait that made the use of sludge in agriculture an attractive option. [20] showed a significant increase in each element nitrogen and phosphorous in the soil and a decrease The percentage of potassium element and an increase in some microelements occurred when increasing the level of addition of sludge, such as zinc, iron and lead. As for the cadmium element.

2. MATERIALS AND METHODS

2.1. MATERIALS

Field experiments *conducted* by one of the private sector projects in Alexandria sub-district, north of Babylon province, for the agricultural season (2019-2020), in which the Silty Clay Loam and alluvial soils were tillage and leveling and Table (1) shows some physical and chemical properties of the soil before cultivation.

Table (1) Some chemical and physical traits of the soil before planting

Traits	Units	Values
EC_e	dSm^{-1}	4.7
pH	--	7.6
Ca	$mmol.L^{-1}$	13.2
Mg		10.4
Na		8.7
K		0.7
Cl		16.2
SO_4		12.6
HCO_3		4.2
CO_3		NILL
Gypsum	$g.Kg^{-1}$	4.21
Carbonate mineral equivalent		255
Organic matter		15.40
Total nitrogen		1.60
availability phosphorous	$mg.Kg^{-1}$	7.11
Potassium availability		322
Cation exchange capacitance	$Cmol.charge.Kg^{-1}soil$	26.04
iron availability	$mg.Kg^{-1}$	6.24
Manganese availability		5.62
zinc availability		1.02
copper availability		11.02
lead availability		0.9
cadmium availability		0.02
Texture		
Sand	$g.Kg^{-1}$	188
Silt		480
Clay		332
Bulk density	$Mg.m^{-3}$	1.22

The Randomized Complete Block Design (RCBD)was used with three replicates, the distance between one replicate and another 2 m, and the replicate was divided into 16 experiment units in the form of plot,

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the area of one plot is 2 * 3 m 2 and the distance between one experiment unit and another was 1.5 m, As a preventive measure to prevent the transfer of fertilizer from one plot to another, sewage waste collected from the drying ponds at the Heavy Water Filter Center in Maimirah - Babylon, where it milled and passed on a sieve with a diameter of 4 mm holes and a part taken from it for some different chemical analyzes on it, and Table 2 shows these traits We used four levels of sewage waste, which are (0-40-60-80) tons. ha-1 and mineral fertilizer were used at (200 N kg ha^{-1}) from two sources, such as urea and ammonium sulfate and 50 urea +50 ammonium sulfate for the purpose of comparing. Yellow corn seeds (American hybrid) Zea mays L. were cultivated in the form of lines distance between one line and another 25 cm. Three seeds placed in each pit, and after germination, they were reduced to one plant in each pit and the crop service operations continued until the end of the experiment, and the plants irrigated with water every (7-8) days, according to the plant's need for water. What did you mean cm for the required chemical analyzes, as each of:

Table (2) some chemical traits of the sludge used in the experiment.

Traits	Units	Values
EC (1:5)	dSm^{-1}	3.7
pH (1:5)	--	7.0
Ca		18.1
Mg		31.3
Na		15.5
K	$mmol.L^{-1}$	0.9
Cl		15.8
SO_4		42.3
HCO_3		6.8
CO_3		Nill
Organic matter	$mg.Kg^{-1}$	352.60
Cation exchange capacitance		38.64
Total nitrogen	$Cmol.charge.Kg^{-1}$	12.44
Total phosphorous		14.82
Total potassium		7.22
Concentrations of DTPA-extracted elements		
Iron (Fe)	$mg.Kg^{-1}$	238.51
Manganese (Mn)		47.19
Zn		325.64
Copper (Cu)		31.19
lead (Pb)	$g.Kg^{-1}$	86.09
Cadmium (Cd)		0.25

2.2. METHODS

1-The EC. meter and pH-meter measured for the electrical conductivity and pH of the saturated paste extract, as mentioned in Page et al (1982).
2- The determination of soil organic matter was by Walkley and Black method, as mentioned in Page et al (1982).
3- Total nitrogen of the soil were estimated by digestion with concentrated sulphuric acid, using the micro-Kjeldahl device, according to the Bremner method mentioned in Page et al (1982).

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4- Estimation of soil phosphorus by sodium bicarbonate (Olsen et al. 1954) by performing by a spectrophotometer on a wavelength of (882) nanometers, as mentioned in Page (1982).
5- - Estimating potassium in soils by the neutral ammonium acetate extract, as mentioned in Page (1982).
6- Estimation of the heavy elements (cadmium and lead) was extracted from the soil by using a solution of ammonium bicarbonate and DTPA (Diethylene triamine pentaacetic acid) after adjusting reaction to (pH = 7.6) by add drops of hydrochloric acid and follow-up reading reaction until reaching the required reaction, (20) ml of extraction solution was added to (10) g of soil and agitated for half an hour, then filtered with filter paper (Watman No. 42) and the filtrate was taken and the aforementioned elements were determined using atomic absorption spectroscopy according to the method provided in Havlin and Soltanpour (1981).

3. RESULTS AND DISCUSSION

3.1- Electrical conductivity

Table (3) showedthe electrical conductivity values of an extract of saturated paste increased with the increasing the levels of of addition of sewage residues 40, 60 and 80 ton ha-1, where the mean values reached (5.28-5.59-5.92) dSm-1respectively compared with a control treatment of 4.22 dSm -1, This is consistent with (15)- (6)-(16) obtained, and they due to the reason for the sludge to contain a percentage of salts,

Table (3) Electrical c Effect of addition of sewage residues in electrical conductivity

Sewage wastes $Tn.H^{-1}$	Nitrogen Fertilization 200 Kg/ N.H-1				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	4.18	4.28	4.22	4.21	4.22
40	5.19	5.35	5.27	5.29	5.28
60	5.59	5.59	5.57	5.60	5.59
80	5.88	5.96	5.87	5.95	5.92
Average	5.21	5.29	5.23	5.26	
LSD0.05	S/0.23	S*N/0.46			N/0.23

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3.2- Soil reaction (pH)

The results in Table (4) showed a decrease in the values of soil reaction with an increase in the levels of addition of sewage wastes, and this decrease was significant at the levels of addition (40-60-80) tons Respectively., compared to the control treatment, which amounted to 7.54.This decrease may be due to an increase in the sewage waste content of nitrogen, oxidized with the production of hydrogen ions that reduce the degree of soil reaction and also the decomposition of organic waste results in organic and inorganic acids that reduce soil reaction and this is consistent with what he found (2)- (11) in the observed from the same table, a slight decrease in the values of soil reaction when adding mineral fertilizers, as there was (4) a slight decrease when adding mineral fertilizers to the soil.

Table (4) Soil reaction (pH)

Sewage wastes Tn.H^{-1}	Nitrogen Fertilization 200 Kg/ N.H-1				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	7.56	7.55	7.53	7.54	7.55
40	7.53	7.46	7.37	7.45	7.45
60	7.40	7.39	7.33	7.36	7.37
80	7.32	7.31	7.29	7.30	7.30
Average	7.45	7.43	7.38	7.41	
LSD0.05	S/0.03	S*N/0.06		N/0.03	

3.3- Organic matter

The results in Table (5) show that there is a significant increase in the percentage of organic matter in the soil by increasing the levels of addition of sewage residues. This increase was significant at all levels of addition (40-60-80) tons ha^{-1} compared to the control treatment.Where the values of the increase ranged between (14.3 -18.7) g Kg^{-1}, and this is consistent with what he found (12)-(20). They may be due to the fact that the sludge contains a high percentage of organic matter. There was no significant increase in the percentage of organic matter in the soil with the addition of mineral fertilizer.

Table (5) Effect of addition of sewage residues in organic matter

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Sewage wastes Tn.H-1	Fertilization 200 Kg/ N.H-1 Nitrogen				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	11.23	11.32	11.55	11.46	11.39
40	14.32	14.37	14.43	14.39	14.38
60	16.54	16.69	16.86	16.78	16.72
80	18.54	18.66	18.85	18.76	18.70
Average	15.16	15.26	15.42	15.35	
LSD0.05	S/0.70	S*N/1.4		N/0.70	

3.4- Total nitrogen in the soil

Table (6) show that addition of sewage residues at several levels led to a significant increase in the percentage of total nitrogen in the soil with an increase in the levels of addition, which ranged between 373.1 - 604. mg kg-1 The reason may be due to the fact that the percentage of nitrogen in the sludge, and that the sludge reduces soil reaction and thus the availability of the nutrients increases and that the addition of nitrogen fertilizer led to an increase in the values of nitrogen in the soil and this is obtained by (20)-(17) please the result need to real and deep discussion

Table (6) Effect of addition of sewage residues in total nitrogen in soil

Sewage wastes Tn.H-1	Nitrogen Fertilization 200 Kg/ N.H-1				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	350.8	361.9	391.3	388.4	373.1
40	526.1	538.3	566.5	565.0	459.0
60	571.8	582.0	594.6	591.1	584.9
80	591.1	597.0	615.7	613.0	604.2
Average	509.9	519.8	542.0	539.4	

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LSD0.05	S/3.01	S*N/6.02	N/3.01	

3.5 - Phosphorous availability in soil

The results in Table (7) showed that the addition of sewage residues at several levels (40-60-80) tons. ha^{-1} led to a significant increase in the concentration of availability phosphorus in the soil, which reached 18.2-19.6-21.2 mg. Kg^{-1} compared with the control treatment that amounted to 7.6 mg kg-1The reason may be due to the fact that sewage wastes contain a good percentage of phosphorus and also that sludge has an effective role in reducing soil reaction, and thisleads to an increase in the availability of the phosphorus component, and this is consistent with (4) - (6) –(3). As for mineral fertilizer, there were no significant differences. In the increase of phosphorous in the soil.

Table(7) Effect of addition of sewage residues in phosphorous availability in soil

Sewage wastes Tn.H^{-1}	Nitrogen Fertilization 200 Kg/ N.H-1				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	7.4	7.4	7.8	7.7	7.6
40	17.4	18.2	18.8	18.4	18.2
60	19.1	19.3	20.0	19.8	19.6
80	20.3	20.8	22.5	21.4	21.2
Average	16.1	16.4	17.2	16.9	
LSD0.05	S/0.24	S*N/0.48		N/0.24	

3.6 - potassium availability in the soil

Through the results in Table (8), found that there is a decrease in the values of potassium availability in the soil with an increase in the added levels of sewage residues, where the average concentration of potassium availability in the soil ranged from 294.9, 279.5, and 247.5 mg.Kg^{-1} .The reason for this decrease may be due to the fact that the sludge content of potassium, and the improvement of plant growth, and the increase in *potassium absorption* from the soil,(4)-(6)

Table(8) Effect of addition of sewage residues in potassium availability in soil

Sewage wastes Tn.H^{-1}	Nitrogen Fertilization 200 Kg/ N.H-1				Average
	Without fertilization	Urea	Aluminum sulfate	%+Urea50 Aluminum sulfate50%	
0	315.8	315.7	315.8	315.8	315.7
40	293.8	297.1	294.2	294.8	294.9
60	282.4	283.8	278.7	273.1	279.5
80	258.6	247.6	241.8	242.2	247.5
Average	287.6	286.1	282.9	281.2	
LSD0.05	S/1.4	S*N/2.8		N/1.4	

4. CONCLUSIONS

1- Adding sewage residues to agricultural lands at a level of 80 tons. E-1 contributed to improving the chemical properties of the soil and increasing the readiness of plant nutrients, which reflected positively on plant growth and productivity besides being considered the best way to get rid of sewage waste.
2- The lack of an increase in the concentration of heavy elements in the studied soil and plants. This encourages the use of sludge in the agricultural field in Iraq.
3- Sewage waste can be added to agricultural lands at a level of 80 tons. E-1 with mineral fertilizer in order to increase the yield of the yellow corn crop without contamination with heavy elements.
4- Sludge did not raise the level of both cadmium and lead in either plant or soil to critical or toxic levels that could have negative effects on humans, animals or plants.

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