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EFFECT OF SEWAGE WASTES (SLUDGE) ON SOME CHEMICAL TRAITS OF SOIL

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ABSTRACT

A field experiment was conducted to study the effect of different levels of sludge on some chemical properties of soil. The experiment was conducted in the Alexandria district of Babylon province, using The Randomized Complete Block Design (RCBD) with three replicates. Four levels of sludge were used, which are (0, 40, 60, 80 tons. ha^{-1}) and which is symbolized by (S4, S3, S2, S1, S0) respectively, and nitrogen fertilizer was used from two nitrogen sources and three levels, namely urea and ammonium sulfate. The two were mixed, and the seeds of yellow corn were cultivated in hybrid cultivars as botanical evidence. Soil samples were taken after harvesting for the required analyzes. The results showed a significant increase in the electrical conductivity (EC) values for all levels of sludge addition (80, 60, 40, 0), where the values reached (4.35, 4.73, 5.47, 5.81) dSm^{-1} respectively, while mineral fertilization gave an increase. not significant in electrical conductivity values, There was a decrease in the degree of soil reaction (pH) from (7.54) to (7.31) 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, in the case of a decrease in the concentration of potassium in the soil from (315.7 to 247.5) $mg.Kg^{-1}$ 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 (15.4) -24.1) $g.Kg^{-1}$.
***Keywords*:** sewage waste - sludge - soil chemical traits

Introduction

The Sewage sludge waste was defined according to the standard specifications for the use of Sewage sludge in Iraq as a mixture of solid, organic and inorganic materials and treated by aerobic and anaerobic fermentation and water removal from it (Iraqi Ministry of Environment- 2016) 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 (Samaras and Tsadilas, 1999). Julierme (2017) found that adding sewage sludge to the soil leads to the 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. The use of sewage wastes in agriculture is considered 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 (Clidar and others, 2010). (Urbaniak and others, 2016) explained that the use of sewage sludge in agriculture is not a modern matter, due to the importance of the sludge in supplying the soil and plants with organic matter and nutrients, especially nitrogen and phosphorous. (Hamad and Others, 2010) indicated 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 the presence of salts in sewage waste. (Angin and Yaganoglu, 2011) 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. (Zahlan and others, 2016) showed that the 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, respectively (20-40-60 $tons.ha^{-1}$) and (Al-Azzawi, 2014) indicated 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 (Hussein and other-2010) and (USMAN and other-2012) that sewage wastes and adding them to the soil at the level of (90 $ton.ha^{-1}$) have an important role in reducing the degree of 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 outputs of acidic sewage wastes and the effectiveness of Microbiology in the soil and (Prism, 2006) showed in a study on sewage sludge, indicating that there is a decrease in the values of the degree of soil interaction with an increase in the levels of added sludge (25.50. (0.9, 1.4, 2.1, 3.7%) respectively, 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 the degree 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. (MCLAUGHLIN, 2010), (Karef and other, 2014), (Singh and other, 2009) showed that sewage wastes work to increase the organic matter in a clear way, 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 (Bai and other, 2017). (Hussein and other, 2010), (Walid, 2019), (Ali and other, 2013) 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 the traits that made the use of sludge in agriculture an attractive option. (Abboud and others, 2009) 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, it remained constant in the soil due to the fact that it has a small percentage in the sludge.

Table 1 : Some chemical and physical traits of field soil before cultivation

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

Table 2 : Some chemical traits of the sludge used in the experiment.

Values	Units	Traits	
3.7	dSm^{-1}	EC (1:5)	
7.0	——	PH (1:5)	
18.1	$mmol.L^{-1}$	Ca	Dissolved Ions
31.3		Mg	
15.5		Na	
0.9		K	
15.8		Cl	

42.3		SO_4	
6.8		HCO_3	
Nill		CO_3	
34.60	$g.Kg^{-1}$	Gypsum	
175		Limestone	
352.60		Organic matter	
38.64	$Cmol.charge.Kg^{-1}soil$	Cation exchange capacitance	
12.44	$g.Kg^{-1}$	Total nitrogen	
14.82		Total phosphorous	
7.22		Total potassium	
	$\mu g.Kg^{-1}$	Concentrations of DTPA-extracted elements	
238.51		Iron (Fe)	
47.19		Manganese (Mn)	
325.64		Zn	
31.19		Copper (Cu)	
86.09		lead (Pb)	
0.25		Cadmium (Cd)	

Materials and Methods

A field experiment was conducted in 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 of the physical and chemical properties of the soil before cultivation.

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, 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 was collected from the drying ponds at the Heavy Water Filter Center in Maimirah - Babylon, where it was milled and passed on a sieve with a diameter of 4 mm holes and a part was taken from it for some different chemical analyzes on it, and Table 2 shows these traits. Four levels of sewage waste were used, 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 were 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 were irrigated with water every (7-8) days, according to the plant's need for water. -30) cm for the required chemical analyzes, as each of:

1- The electrical conductivity and pH of the saturated paste extract were measured by EC. meter and pH-meter as mentioned in Page (1982).

2- The organic matter was estimated by Walkley and Black method, as mentioned in Page (1982).

3- Total nitrogen was estimated by digesting the soil with concentrated sulfuric acid, using the microchloride device, according to the Bremner method mentioned in Page (1982).

4- The phosphorus extracted by sodium bicarbonate (Olsen et al. 1954) was estimated and the measurement was performed by a spectrophotometer on a wavelength of (882) nanometers, as mentioned in Page (1982).

5- The potassium availability was estimated in the neutral ammonium acetate extract, as stated in Page (1982).

6- The heavy elements (cadmium and lead) were estimated as they were extracted from the soil by using a solution of ammonium bicarbonate and DTPA (Diethyltriamincpenta acetic acid) after adjusting the degree of reaction to (pH = 7.6) by adding drops of hydrochloric acid and follow-up reading the degree of reaction until reaching the required degree of 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 estimated in it using the atomic absorption device according to the method provided in Havlin and Soltanpour (1981).

Results and Discussion

Electrical conductivity

Table (3) that the electrical conductivity values of an extract of saturated paste increased by increasing the levels of addition of sewage residues (40-60-80) tons. ha^{-1}, where the mean values reached (4.73-5.47-5.81) dSm^{-1} respectively compared with a control treatment of 4.35 dSm^{-1}, This is consistent with (Singh -2009)-(Hamad and Others–2010)-(Bai -2017) obtained, and they due to the reason for the sludge to contain a percentage of salts, while the addition of mineral fertilizers from different sources led to increase in the electrical conductivity values, where these values ranged between 4.90-5.22 dSm^{-1} This is consistent with Ahmad (2010)showed found a slight increase in conductivity values when adding mineral fertilizers.

The degree of soil reaction (pH)

The results in Table (4) showed a decrease in the values of the degree 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, which is oxidized and production hydrogen ions that reduce the degree of soil reaction and also the decomposition of organic waste results in organic and inorganic acids that reduce the degree of soil reaction and this is consistent with what he found (Samaras,Tsadilas-1999)-(USMAN-2012) in the observed from the same table, a slight decrease in the values of the degree of soil reaction when adding mineral fertilizers, as there was (4) a slight decrease when adding mineral fertilizers to the soil.

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 (15.4 -24.2) g. Kg^{-1}, and this is consistent with what he found (Prism–2006)-(Abboud and others – 2009). They may be due to the reason for 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 3 : Electrical conductivity

Average	($^{1-}$**H.N/ KG**200) **Nitrogen Fertilization**				**Sewage wastes**
	50% + **Urea %50 Aluminum sulfate**	**Aluminum sulfate**	**Urea**	**Without fertilization**	($^{1-}$**H .Tn**)
4.22	4.21	4.22	4.28	4.18	0
5.28	5.29	5.27	5.35	5.19	40
5.59	5.6	5.57	5.59	5.59	60
5.92	5.95	5.87	5.96	5.88	80
	5.26	5.23	5.29	5.21	Average
LSD- S=0.23 LSD- N=0.23 LSD-S*N=0.46					LSD .05

Table 4 : The degree of soil reaction(pH)

	($^{1-}$**H.N/ KG**200) **Nitrogen Fertilization**				**Sewage wastes**
Average	**Aluminum sulfate** 50% + **Urea %50**	**Aluminum sulfate**	**Urea**	**Without fertilization**	($^{1-}$**H .Tn**)
7.55	7.54	7.53	7.55	7.56	0
7.45	7.45	7.37	7.46	7.53	40
7.37	7.36	7.33	7.39	7.40	60
7.30	7.30	7.29	7.31	7.32	80
	7.41	7.38	7.43	7.45	Average
LSD- S=0.03 LSD- N=0.03 LSD-S*N=0.06					LSD .05

Table 5 : Organic matter

Average	($^{1-}$**H.N/ KG**200) **Nitrogen Fertilization**				**Sewage wastes**
	50% + **Urea %50 Aluminum sulfate**	**Aluminum sulfate**	**Urea**	**Without fertilization**	($^{1-}$**H .Tn**)
11.39	11.46	11.55	11.32	11.23	0
14.38	14.39	14.43	14.37	14.32	40
16.72	16.78	16.86	16.69	16.54	60
18.70	18.76	18.85	18.66	18.54	80
	15.35	15.42	15.26	15.16	Average
LSD- S= 0.70 LSD- N=0.70 LSD-S*N=1.4					LSD .05

Total nitrogen in the soil

Table (6a) that the 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 373.1-604.2 mg.Kg^{-1}. The reason may be due to the percentage of nitrogen in the sludge, as well as that the sludge reduces the degree of 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 what was obtained by (Abboud and others–2009)-(Al-Hussein and others-2019) where they found an increase in the percentage of Nitrogen in the soil when adding sludge fertilizer and due to the reason to the role of waste in increasing the availability of nutrients and their high content of nitrogen.

Phosphorous availability in soil

The results in Table (6b) 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^{-1}.The 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 the degree of soil reaction, and this, in turn, leads to an increase in the availability of the phosphorus component, and this is consistent with (Clidar and others–2010)-(Hamad and Others

– 2010) –(Julierme-2017). As for mineral fertilizer, there were no significant differences. In the increase of phosphorous in the soil.

Potassium availability in the soil

Through the results in Table (6c), it was 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 294.9-279.5-247.5 mg.Kg^{-1}. The reason for this decrease may be due to the sludge content of potassium, as well as the improvement of plant growth and the increase in potassium absorption from the soil, (Clidar and others – 2010)- (Hamad and Others– 2010).

Table 6a : Total nitrogen in the soil

Average	(1-H.N/ KG200) Nitrogen Fertilization				Sewage wastes (1-H .Tn)
	50% + Urea %50 Aluminum sulfate	Aluminum sulfate	Urea	Without fertilization	
373.1	388.4	391.3	361.9	350.8	0
549.0	565.0	566.5	538.3	526.1	40
584.9	591.1	594.6	582.0	571.8	60
604.2	613.0	615.7	597.0	591.1	80
	539.4	542.0	519.8	509.9	Average
LSD- S=3.01 LSD- N=3.01 LSD- S*N=6.02					LSD .05

Table 6b : Phosphorous availability in soil

Average	(1-H.N/ KG200) Nitrogen Fertilization				Sewage wastes (1-H .Tn)
	50% + Urea % 50 Aluminum sulfate	Aluminum sulfate	Urea	Without fertilization	
7.6	7.7	7.8	7.4	7.4	0
18.2	18.4	18.8	18.2	17.4	40
19.6	19.8	20.0	19.3	19.1	60
21.2	21.4	22.5	20.8	20.3	80
	16.9	17.2	16.4	16.1	المعدل
LSD- S=0.24 LSD- N=0.24 LSD S*N=0.48					LSD .05

Table 6c : Potassium availability in the soil

Average	(1-H.N/ KG200) Nitrogen Fertilization				Sewage wastes (1-H .Tn)
	50% + Urea %50 Aluminum sulfate	Aluminum sulfate	Urea	Without fertilization	
315.79	315.87	315.8	315.7	315.8	0
294.98	294.83	294.2	297.1	293.8	40
279.51	273.17	278.7	283.8	282.4	60
247.57	242.27	241.8	247.6	258.6	80
	281.28	282.9	286.1	287.6	Average
LSD- S=1.4 LSD- N=1.4 LSD- S*N=2.8					LSD.05

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