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Assessment of Nitrification and Ammonia Volatilization in Different Soils Texture Irrigated by Waste Water

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Abstract: ***A laboratory incubation experiment was conducted to assessment of nitrification and ammonia volatilization in different soils texture irrigated by waste water. In this study to determinate the rate of recovery NH_4^+, NO_3^- and NO_2^- 250g of air derided soil were placed in 500 screwed conical flask and (100ppm NH_4) added as$(NH_4)_2SO_4$,then treated with two level of waste water of (T_0=control and T_1=treatment) waste water was applied to achieve a soil moisture content equivalent to 60% of the water-holding capacity, 5ml of boric acid indicator solution added to test tube , the test tube putted inside the conical flask and the conical flask was capped and placed in an incubator maintained at 30°C. The ammonia evolved was trapped in boric acid (the color change from red to green) and determined by titration with standard H_2SO_4 0.01N. The results show the nitrification rate increased from light soil texture to heavy soil in texture the higher value of accumulated nitrate was found in silty loam texture compared to other soils texture, as well as the result indicated that the volatilized ammonia is higher in sandy clay loam soil compared to other soil texture which attained 5.457 mg kg^{-1},hoevere, addition of waste water to the soils resulted in a increase nitrification and decrease in the ammonia volatilization .***

Keywords: Nitrification, ammonia volatilization, Soil texture, waste water**,** irrigation

1. Introduction

The use of wastewaters for agricultural irrigation purposes can reduces and prevent the amount of water that required to be extracted from environmental water sources , Hoverer water is a vital resource but a severely limited one in most countries [1]. In arid and semi-arid regions, water resources of good quality are becoming rare and are being allocated with priority for urban water supply. Therefore, there is an increasing essentiality to irrigate with water that already contains salts, such as saline groundwater, drainage water, and treated wastewater [2]. Recently, the amounts of wastewater are sharply increasing and the kinds of pollutants are also varied as the world wide industry is being developed incessantly. With respect to both the quantity and composition, the textile processing wastewater is recorded as the most polluted sources among all industrial sectors [3]. [4] they investigated comparative the effects of wastewater on soil chemical properties in three irrigation methods. The results showed that the application of wastewater in DI (Drip Irrigation) caused an increase of EC, OM, SO_4, Ca, Na, Cl and a decrease of hydraulic conductivity, porosity, Pb and moisture point of soil DI and FW (Fresh Water) treatments. An investigated carried out to study the effect of treated wastewater on soil chemical and physical properties in an arid region. Treated wastewater showed no effect on the increase of Fe, Cd, Ni, Cu and Zn during growing season. The irrigation system had a significant effect on infiltration rate, bulk density and total porosity [5]. [6] investigated soil solution chemistry of a brazilian oxisol irrigated with treated sewage effluent. Results about C and N chemistry showed mineralization of dissolved organic matter and rapid nitrification from ammoniac and organic nitrogen provided by effluent. The nitrate concentration decreased by plant uptake but also by leaching during the rainy season, pointing out a long-term risk of contamination of shallow groundwater environments. Soil microbial response to waste water have been recommended as nearly warning indicator of ecosystem stress, because of the quick response to changes in environmental condition. One process of considerable ecological importance is nitrification. In most agricultural soils, ammonium (NH_4^+) from fertilizer is quickly converted to nitrate (NO_3^-) by the process of nitrification. This process is crucial to the efficiency of N fertilizers and their impact on the environment, because the net effect is a conversion of fertilizer N from a form that is not normally subject to loss from soil (NH_4^+) into a form that is readily lost by leaching or denitrification NO_3^-. [7]. Nitrification occurs in two steps: NH_4^+ is first converted to nitrite (NO_2^-), and the NO_2^- is then converted to NO_3^-. Both reactions are carried out by bacteria present in the soil. Nitrifying bacteria are chemoautotrophic, in that they produce energy by chemical oxidation of NH_4^+ or NO_2^- and utilize CO_2 as a source of C. Different groups of bacteria are responsible for the two steps involved in nitrification. The NH_4^+-oxidizing bacteria include species from five genera, the most common being Nitrosomonas, the NO_2--oxidizing bacteria all belong to the genus, Nitrobacter. Because there are only a few species of nitrifying bacteria, nitrification is much more sensitive to environmental conditions than are most other N transformations, which are carried out by a more diverse group of microorganisms [8]. The effect of waste water on nitrification and number of microorganism depending up on their concentration , rate an d period of application. The ammonia volatilization is the most important method for nitrogen losses in soil, Urease activity and soil buffering capacity are very important soil properties affecting ammonia volatilization [9]. Other soil properties such as cation exchange capacity, soil texture and organic matter content also affect ammonia volatilization. The rate of nitrification increases with soil temperature up to about 35°C ; below 5°C very little NO_3^- is formed. Soil pH is also important. Below a pH of 6.0, nitrification is inhibited by acidity, and the process virtually ceases at a pH of 4.5 to 5.0. Under alkaline conditions, production of NO_3^- is markedly enhanced. The optimum pH is normally between 7.0 and

8.0.[10], this range of pH is close to Iraqi Kurdistan soil range, although nitrification and ammonia volatilization in agricultural soils has been studied, most of the studies have been conducted to investigate the effect of some environmental factors such as temperature , relative humidity and soil moisture content. [11]. A few study carried out to examine the effect of waste water on nitrification in soil of Kurdistan region. Thus, the objectives of this study were: (i) to evaluate the rate of NO_3^- and NO_2^- and NH_3 product from different soil through nitrification and ammonia volatilization ; and (ii) to determine whether the effect of waste water on nitrification and ammonia volatilization .

2. Materials and Methods

2.1 Laboratory Study

The soils used were surface (0-30 cm) samples originated in different regions of Iraq Kurdistan region. The samples were sieved 2mm screen, Then analysis to determination some physical , chemical, and biological properties according to methods described by [12] and [13]. Table (1). To determinate the rate of recovery NH_4^+, NO_3^- and NO_2^- 250g of air derided soil were placed in 500 screwed conical flask and (100ppm NH_4) added as$(NH_4)_2SO_4$,then treated with two level of waste water of (T_0=control and T_1=treatment) waste water was applied to achieve a soil moisture content equivalent to 60% of the water-holding capacity, 5ml of boric acid indicator solution added to test tube, the test tube putted inside the conical flask and the conical flask was capped and placed in an incubator maintained at 30°C. Measurement of ammonia volatilization loss was carried out daily according to method described by [14]. The ammonia evolved was trapped in boric acid (the color change from red to green) and determined by titration with standard H_2SO_4 0.01N. After 30 days triplicate flask were removed from the incubator, 250 ml of 2 M KCl adding to each flask. The KCl Soil solution was extracted by shaking for 1h and filtering the resulting suspension under vacuum. The soil extract was analyzed for NH_4^+-N by indophenol blue method [13],while NO_3^- determined by UV spectrophotometer method as described by [15],where as NO_2^- estimated by colorimetric procedures [9],[16].

2.2 Statistical Analysis

The experiment was designed in factorial completely randomized design with three replications. The experimental data were analyzed by using SPSS program and differences between the treatment means were separated by LSD test. [17].

Table 1: Some physical, chemical and biological properties of soils under study

Soil proprties		S_1	S_2	S_3	S_4
PSD $g.Kg^{-1}$	Clay	70	479	214	314
	Silt	230	401	266	416
	Sand	700	120	520	270
Textural name		Sandy Loam	Silty Loam	Silty Clay	Sandy Clay Loam
pH		7.5	7.5	7.6	7.8
ECe dSm^{-1}		1.22	1.55	1.63	1.34
Field Capacity %		21.58	32.29	35.77	26.93
Wilting point %		13.6	21.4	19.4	14.3
Nitare $mg.kg^{-1}$		3.24	2.54	1.65	2.98
Ammonium $mg.kg^{-1}$		0.43	1.1	1.8	0.66
Organic matter $g.kg^{-1}$		1.4	2.6	1.5	1.65
$CaCO_3$ $g.kg^{-1}$		145	210	240	256
Total count of bacteria g^{-1} soil		$102*10^4$	$196*10^5$	$189*10^5$	$169*10^5$
Total count of fungi g^{-1}soil		$25*10^3$	$92*10^3$	$88*10^3$	$68*10^3$

3. Results and Discussion

In the nitrogen cycle of the soil, nitrate and ammonium have a central position since they are the most bioavailable nitrogen for plants. Nitrification and ammonia volatilization are attest suitable for assessing the effect of waste water on soil organisms because of their sensitivity and the agronomic significance of these processes. The data in table (2) show the nitrification rate increased from light soil texture to heavy soil in texture the higher value of accumulated nitrate was found in silty loam texture compared to other soils texture, the reason may be due to the fact that the silt increase the size of space between particles, thus facilitating the movement of air and drained water, it means that silty loam soil supply adequate oxygen to meet the requirements of nitrifies microorganisms and stimulate nitrification. As well as the result in the same table indicated that the volatilized ammonia is higher in sandy clay loam soil compared to other soil texture which attained 5.457 mg kg^{-1} , this may be due to the effect of soil pH (7.8) because all study refer to present the positive relationship between ammonia volatilization and soil pH. These results agree with those reported by [18]. They reported that the ammonia volatilization increased with increasing g the soil pH. The data obtained with the interaction effect of waste water and soils texture on nitrification and ammonia volatilization are reported in table(3), the result show that waste water application partially increase the nitrification and decrease the ammonia volatilization, generally the high value of nitrification71.985 mg kg^{-1} and ammonia volatilization 6.554 mg kg^{-1} was recorded form the interaction treatments S_2T_0 and S_4T_0 respectively. The result may be due to the effect of number of organisms and the calcium carbonate in both soils respectively. [19].

Table 2 : Effect of soils texture on nitrification and ammonia volatilization

Soils	*Nitrification mg.Kg^{-1}*			*Volatilization mg.Kg^{-1}*
	NH_4	*NO_3*	*NO_2*	*NH_3*
S_1 Sandy Loam	*32.100*	*61.885*	*0.879*	*2.797*
S_2 Silty Loam	*19.898*	*71.196*	*1.569*	*4.998*
S_3 Silty Clay	*25.485*	*67.142*	*1.203*	*3.831*
S_4 Sandy Clay Loam	*24.713*	*65.778*	*1.714*	*5.457*
LSD 0.05	*5.267*	*5.241*	*0.067*	*0.212*

Table 3: Effect of waste water on nitrification and ammonia volatilization in difference soils texture

Treatments	Nitrification mg.Kg^{-1}			Volatilization mg.Kg^{-1}
	NH_4	NO_3	NO_2	NH_3
S_1T_0	34.560	59.664	0.822	2.615
S_1T_1	29.640	64.106	0.936	2.979
S_2T_0	18.195	71.985	1.788	5.693
S_2T_1	21.600	70.407	1.351	4.302
S_3T_0	25.305	66.867	1.312	4.177
S_3T_1	25.665	67.417	1.095	3.485
S_4T_0	26.610	62.439	2.058	6.554
S_4T_1	22.815	69.116	1.369	4.360
LSD 0.05	7.449	7.411	0.095	0.300

The data in figure (1and 2) revealed that the waste water has a significant effect on nitrification and ammonia volatilization in different soils texture. Addition of waste water to the soils resulted increase in nitrate production it means high nitrification compared to the same soil when waste water was not added. The decrease in the ammonia volatilization in the presence of the waste water resulted in large fixation due to soil reaction and other soil properties. This result could be explained on the ground that the heavy soil due to its increase area of surface exposed to solution their particles have the capacity to hold nutrients and other compound also microorganism attract to these area, by this way the application of water may increases the activity and number of microorganisms in soil , however , heavy soil not only have the capacity to attract and hold nutrients and compounds on their surface , but the also hold much more water may causes too much water holding capacity and not enough aeration, in addition Irrigation with wastewater decreased soil pH and subsequently increase the nitrification and decrease the ammonia volatilization . The reason is likely due to the decomposition of organic matter and production of organic acid in soils irrigated with wastewater [20]. This is in line with findings of [21],[22],[23]. They concluded that the reuse of wastewaters for purposes such as agricultural irrigation can reduces the amount of water that needs to be extracted from environmental water sources. Soil irrigated with wastewater caused increase of EC, P, OM, TN, K, Na, Cl, Fe, Cd and Zn but it caused a decrease of soil pH. As well as result showed that soil irrigated with wastewater caused a decreased of BD.

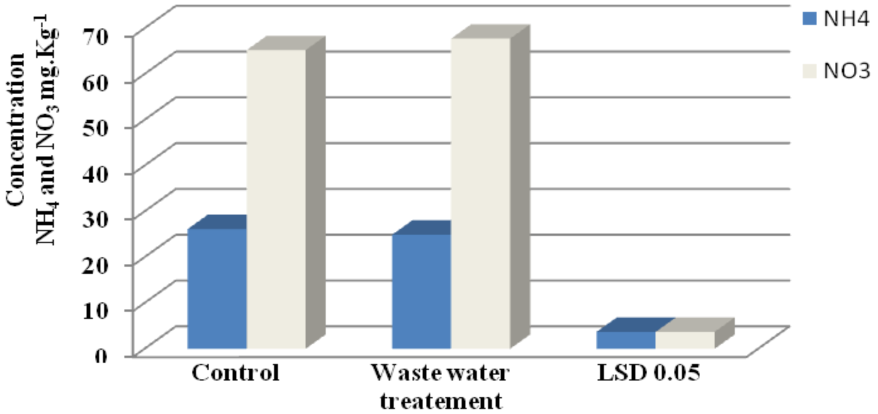
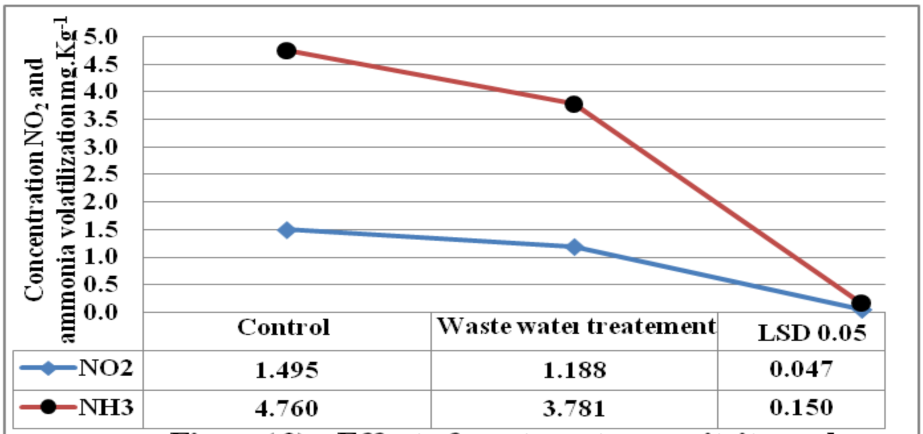


Figure (1) : Effect of waste water on ammonium and nitrate concentration mg.Kg^{-1}



Figure(2) : Effect of waste water on nitrite and ammonia volatilizationmg.Kg^{-1}

4. Conclusion

The present study concluded that the nitrification rate increased from light soil texture to heavy soil in texture the higher value of accumulated nitrate was found in silty loam texture compared to other soils texture, as well as the volatilized ammonia is higher in sandy clay loam soil compared to other soil texture which attained 5.457 mg kg^{-1},hoevere, addition of waste water to the soils led to in a increase nitrification and decrease in the ammonia volatilization .

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