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Study of Microbial Biomass activity in Saline Soils.

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ABSTRACT

Six soil samples were collected from 6 different locations in Baghdad city. The soil samples had electrical conductivity (EC) gradient from 2.51-13.14 ds m^{-1}. Some microbial biomass characteristics including: microbial Biomass C (MBC), microbial biomass N (MBN), C/N, N-mineralization and Nitrification, soil respiration (amount of CO_2 evolution) were measured. Results showed negative relation between EC and MBC and MBN. The MBC of soils decreased From 190.30 to 28.64 mg kg^{-1} and MBN from 46.52 to 3.55 mg kg^{-1} soil with EC from 2.51 to 13.14 ds m^{-1}, respectively. On the other hand, the results showed positive relations between C/N and EC. The C/N ratio of soil microbial biomass increased with increasing salinity. N-mineralization, nitrification and CO_2 evolution observed decreasing in this index. Results indicated that soil microbial biomass were highly sensitive to salinity which more detrimental effect on the soil microbial community.
Keywords: Microbial biomass, soil salinity, EC.

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INTRODUCTION

High salts content not only affect physical and chemical properties of soil but also affect soil microbiological properties. Increases in salinity have been shown to decrease soil microbial biomass [20]. The salinity is one of the most important factors affecting the agricultural production of the world countries, especially arid and semi-arid regions [10].

The reason for the reduced size and activity of the microbial community with increasing salinity is likely to be osmotic stress which is caused by large concentrations of salts in soil solutions Osmotic stress usually limits microbial growth and activity in saline soil [17]. The effect of salinity on ecosystem is directly osmotic pressure which leads to inhibit of the plant to absorb water. As well as to influence the nutritional balance in the soil. The indirect effect is the impact of sodium ion on Physical and chemical properties of soil, these different effects lead to a lack of growth [5, 19].

The high level of salinity affects microbial activity in the soil which is reflected on the amount of carbon and nitrogen biomass. The high levels of salinity in the soil inhibits soil mineralization, as the reverse process of nitrification (denitrification) will affect soil fertility and productivity of the plant as well as the inhibition of microbial activity represented by the low level of metabolic output and efficiency [7].

The saline agricultural soils will suffer of the damage happening to the microbial biomass particularly biochemical characteristics as well as the Physical and chemical properties [12]. One of the important criteria that are represents as an indicator of the microbial soil health and metabolism of microbial biomass [13]. Salty that the high amount of carbonate and bicarbonates in the first division in the sodium ion of soils and irrigation water greatly affect the physical properties such as the movement of water and soil erosion [11]. Found positive linear relationship between carbon microbial biomass and organic carbon in the soil [12].
The main objective of this study is to understand the relation between soil physic-chemical properties and soil biological properties in Baghdad city soils. Also, study the effect of salinity and alkalinity increasing on microbial biomass and activity as well as on N mineralization.

MATERIALS AND METHODS

Samples collection and preparation

Six soil samples were collected from deferent locations at Baghdad city, Baghdad, Iraq. These samples were obtained from surface area (0- 20 cm) in plastic bags and transferred to lab. The samples were divided to 2 parts; the first was stored in refrigerator at 4 °C and another one was air dried. The air dried samples were used to determine physicochemical properties of collected soil samples. But, the refrigerator samples were used to determine microbiological properties.

Physicochemical analysis of soil

The physicochemical properties of collected soil samples were investigated. Soil samples were analyzed for pH and electric conductivity (EC); employing the standard methods [4]. As well as the organic carbon (soil organic matter) and soil particles distribution were measured as presented by [16]. The EC values were determined using digital YSiEC meter (model 35) and the pH was measured by digital ORION pH meter (model 420A).

Biological analysis

The biological properties of tested soil samples were determined in part of samples which stored at 4 °C. the organic carbon and nitrogen of soil samples were measured using chloroform fumigation extraction (CFE) method [21]. A series of preliminary tests was conducted with soil to identify the optimal amount of soil and an adequate soil: chloroform ratio for fumigation, using criteria such as total amounts of extractable C and N after fumigation and their variation among replicates. Based on these preliminary tests and the results presented in this paper, the following CFE procedure was developed for fumigation at atmospheric pressure (CFAP), i.e. fumigation without vacuum application. Water-saturated soil equivalent to 25 g in oven-dry basis (48 h at 105 °C) was weighted into 250-ml glass bottles with screw caps. Un-fumigated control soils were extracted immediately with 140 ml of 0.5 M KCl solution (approximately 1: 4 w/v) for 60 min using an end-over-end shaker at 35 rev min^{-1}, and filtered through a Whatman no. 42 filter paper. Preliminary tests showed that a small contamination of the soil extract with C derived from the filter paper could be avoided by discarding the first 2 ml of each KCl extract. Soil samples for fumigation each received 2 ml ethanol-free chloroform. Ethanol was removed by washing 100 ml chloroform (reagent grade) with 100 ml of 5% H_2SO_4 using a separating funnel. Thereafter, the chloroform was washed 3 times with 100 ml deionized water.

For fumigation, bottles were closed and agitated to spread the soil over the inner surface of the bottles, to mix the soil with chloroform, and to expose the maximum surface area to chloroform vapour. After incubation for 24 h in the dark at 25 $^{\circ}$C, the chloroform was allowed to evaporate in the fume hood at 25 $^{\circ}$C for 30 min before soils were extracted with 140 ml of 0.5 M KCl solution as described above.

The nitrogen of microbial biomass was calculated from the following equation: [6].

Biomass N = (Fn – Efn)/ Kn

Where: Fn= N of treated soil by chloroform
Efn= N of untreated soil by choloroform
Kn= 0.54

In case of carbon of microbial biomass, beaker of NaOH was put with soil in desiccator and titrated using HCL after incubation period. The carbon of microbial biomass was calculated using following equation [7].

Biomass C = (Fc - Efc)/ Kc

Where, Fc = CO_2 from treated soil by chloroform
Efc = CO_2 from untreated soil by chloroform
Kc = 0.45

Determination of mineral nitrogen

The mineral soil nitrogen was determined by measure the ammonia and nitrate content in soil samples using standard methods [4].

Soil respiration

The respiration of tested soil samples was calculated by put 25 g of soil in desiccator containing beaker involved NaOH solution. After 10 days of incubation, the produced CO_2 was measured by titration of NaOH with HCl [1].

RESULTS AND DISCUSSION

Physic-chemical properties of soil

The physicochemical properties of collected soil samples were studied. These properties such as EC, pH, percent of organic carbon and type of soil and the result were illustrated in Table (1). The electric conductivity of tested samples was varied and ranged between 2.51 to 13.14. These soil samples are considered as salty soil [10].

Carbon and nitrogen of microbial biomass

Microbial biomass carbon (MBC)

The carbon of microbial biomass was determined in collected soil samples and results were represented in Table (2). The results showed that the amount of microbial biomass carbon (MBC) in the soil was varied depending on the electrical conductivity (EC) values of the soil which reflect the level of salinity.

The MBC level was 190.30 mg kg^{-1} soil when the soil EC was 2.51 ds m^{-1}. While it was 28.64 mg kg^{-1} when the EC of the soil 13.14 ds m^{-1}. These results confirm that the salinity of soil has negative impact on soil MBC and the level of carbon biomass decreased with the increase in the level of soil salinity [9].In another study [2] observed that the amount of MBC in unsalted soil was 100-600 mg kg^{-1} soil while it was in salty soils 125-445 mg kg^{-1} soil.[19] found that the level of salinity of the soil when it is higher than 16 ds m^{-1} in highly saline coast soils caused a decrease in the amount of microbial biomass carbon. Results of the study were agreed with results of previous studies which confirm the low amount of microbial biomass carbon when increasing levels of soil salinity.

Table 1: Some physicochemical properties of tested soil samples

Sample No.	EC ds/m	pH	Organic C %	Soil type		
				Clay	Silt	Sand
1	2.51	7.20	0.46	125	401	474
2	4.10	7.15	0.39	345	355	300
3	6.85	725	0.31	206	552	242
4	8.20	7.52	0.26	308	505	187
5	10.05	7.33	0.25	200	560	240
6	13.14	7.10	0.22	324	511	165

Microbial Biomass Nitrogen (MBN)

The results of microbial biomass nitrogen (MBN) were represented in Table (2). Results indicate that the MBN was low at high levels of Salinity and found reverse relations between the EC and MBN in soil. The amount of nitrogen is very low (3.55 mg kg^{-1}) when the soil EC was 13.14 ds m^{-1}, while the amount of microbial biomass nitrogen increased and amounted to 46.52 mg kg^{-1} in the soil with the EC 2.51 ds m^{-1}. These results show clearly influence the level of salinity of the soil microbial biomass and activity which reflected in the decline of nitrogen to increase the levels of soil EC, and observed negative relations between the MBN in soil and the EC. These results were agreed with results of several studies [11, 17, 18], which confirmed the decline in the amount of microbial biomass nitrogen in the affected soil salinity.

Table 2: Relations between EC and soil biological properties.

Sample No.	EC ds/m	MBC mg kg^{-1}	MBN mg kg^{-1}	C/N ratio
1	2.51	190.30	46.52	4.09
2	4.10	143.11	25.92	5.52
3	6.85	94.14	15.20	6.19
4	8.20	63.71	9.18	6.94
5	10.05	41.10	5.74	7.16
6	13.14	28.64	3.55	8.60

C/N Ratio of microbial biomass

The relation between Carbon percent and nitrogen percent of microbial biomass in soil was investigated in this study and the results of C/N ratio were illustrated in Table (2). The results showed a positive relation between the level of soil salinity (EC values) and C/N ratio. These results were differenced to other relations between EC and soil microbial biomass in Table (2). The results showed that the C/N ratio of microbial biomass was 4.09 at low salinity level (EC 2.51 Ds m^{-1}), while the C/N ration was increased to 8.60 when the EC increased to 13.14 Ds m^{-1}. The same results were obtained by [22]. Also Chander and [3] found that a large value in the C/N ratio of microbial biomass to soil after treatment with glucose.

Nitrogen Mineralization

The results showed that the mineralization process of nitrogen was varied based on the difference in levels of soil salinity (EC), There was a decrease in the values of mineralization at the high level of salinity and gave 8.32 mg N kg^{-1} when the EC was 13.14 ds m^{-1}, while it was 43.50 mg N kg^{-1} soil when the EC 2.51 ds m^{-1}. It has been observed negative relations between nitrogen mineralization and microbial biomass levels of soil salinity, low results confirmed mineralization of nitrogen values with high levels of soil salinity [15]. It is believed that the cause of low mineral nitrogen is that the salinity of the soil to discourage the decomposition process of organic matter directly by reducing microbial growth and activity. The findings confirmed the results obtained by [14] in their study of mineral nitrogen study on organic soils influenced by salinity.

Nitrogen Nitrification

The nitrification of microbial biomass nitrogen was investigated in this study and the results were represented in Table (3). The results showed that the nitrification process may be affected by increasing levels of the soil EC that had a significant impact on the salinity. Where, the NO_3-N formation was decreased at high leveled of salinity. The value of nitrate was 0.80 mg N kg^{-1} at soil EC 13.14 ds m^{-1}, while the highest value of nitrification was 13.13 mg N kg^{-1} at Soil EC 2.51 ds m^{-1}. The results of previous studies confirm these results [14]. Quanzhong and Guanhua [15] found that the amount of NH_4-N and the amount of NO_3-N were decreased at high levels of salinity because the nitrification process was more sensitive to salinity.

Table 3: Impact of EC values on Nitrification and respiration of soil microbes.

Sample No.	EC ds/m	Soil respiration mg CO_2 Kg^{-1} soil	NH_4-N mg N Kg^{-1} soil	NO_3-N mg N Kg^{-1} soil
1	2.51	40.35	43.50	13.13
2	4.10	36.22	29.99	12.75
3	6.85	28.31	23.38	10.92
4	8.20	22.10	18.15	6.51
5	10.05	14.25	12.00	2.22
6	13.14	6.61	8.32	0.80

Soil Respiration

The respiration process of tested soil samples was determined in this study by measuring of CO_2 liberation. The results were illustrated in Table (3). The results showed that the soil respiration (CO_2-C liberation) synthesis during a period of 10 days of incubation in saline soil decrease liberal quantity of CO_2 at the high level of soil salinity Table (3). The highest value of CO_2 (40.35 mg kg^{-1}) was found at EC 2.51 ds m^{-1}, while it decreased to 0.61 mg kg^{-1} at the EC 13.14 ds m^{-1}. These results indicated that found negative relations between soil salinity and the amount of CO_2 liberation in the soil. These findings were agreed with the results obtained by Vance et al. [21] who showed an increase in the amount of CO_2 liberated 50-80 mg kg^{-1} soil at low levels of soil salinity. In another study point out that the total microbial activity (estimated amount of liberated CO_2) has been reduced by increasing the salinity of the soil [19].

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