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MICROBIAL FERTILIZERS EXISTENCE AND ITS RELATIONSHIP TO HEAVY METALS IN SOME SUSTAINABLE AGRICULTURAL FIELDS IN ANBAR GOVERNORATE

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Abstract

Investigations made and soil samples brought from 14 sites in different areas, including Abu Ghraib and Al Anbar. Tests and measurements made in the Microbiology Laboratory at the College of Agriculture, University of Anbar. Department of Soil Sciences and water Resources, in order to isolate bio-fertilizers and test isolates fixing nitrogen in atmosphere and solvents for phosphorous compounds efficiency. The experiment included isolating and diagnosis of bacteria from rhizosphere soils of different plants that were brought from different agricultural areas, 74 isolates obtained by soils alleviation, and then the bio-chemical morphological and microscopic characteristics of these soils studied. The results showed that the most abundant and frequent isolates were Azotobacter 15 isolates, Bacillus 15 isolates, Pseudomonas 11 isolates, and Azosperillium 10 isolates and Actinomycetes 10 isolates. Nitrifying bacteria of both geneas Nitrosomonas 7 isolates and Nitrobacter 6 isolates were existed while the numbers of bacteria Azotobacter and Bacillus which fixing Nitrogen in free form and solvent phosphate compounds in the soil are exsist in the soil of the rhizosphere of different plants used in research in agricultural fields. The highest biodiversity rate of isolates was found in Fallujah Nuaimia field in 12 hectares, which pepper planted, with an average of 11 isolates and the lowest rate was 2 isolates in the soil of Heet Basayer field were palms planted in an area of 5 hectares. Chemical and physical Features as well as some

heavy elements were estimated elements. Also the concentrations of each site that the samples were taken were estimated. Obtained in the laboratory of the College of Life Sciences at the University of Baghdad. The most important results were the estimated elements were in normal and allowed average except a little increase in zinc concentration 90 mg kg 1 in Sofia field, 7 hectares, were Jet planted, and the concentration of lead was 24.3 mg kg - 1 in Abu Ghraib Nibras field of 80 hectares, which planted with wheat.

Keywords: Biological fertilizers, Heavy Elements, Sustainable Agriculture, Microbial Diversity, Rhizosphere, Pollution.

التحري عن وجود المخصبات الحيوية وعلاقتها بالمعادن الثقيلة في بعض حقول الزراعة المستدامة في محافظة الأنبار

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الخلاصة

اجريت عمليات التحري وجلب العينات من التربة من 14 موقع في مناطق مختلفة شملت أبو غريب والانبار وأجريت التحاليل والقياسات في مختبر الأحياء المجهرية في كلية الزراعة جامعة الانبار قسم علوم التربة والموارد المائية لعزل المخصبات الحيوية واختبار كفاءة العزلات المثبتة للنتروجين الجوي والمذيبة لمركبات الفسفور، وتضمنت التجربة عزل وتشخيص بكتريا من ترب رايزوسفير نباتات مختلفةُ التي جلبت من مناطق زراعية مختلفة، إذ تم الحصول على 74 عزلة من خلال عمل تخافيف لهذه الترب ودرست الصفات الكيموحيوية والمورفولوجية والمجهرية لها. بينت النتائج ان أكثر العزلات تواجد وتكرار هي الازوتوباكتر 15 عزله والباسلص 15 عزله والسيدوموناس 11 عزلة والازسبريليام. 10 عزله ولاكتينومايسيت 10 عزله، تواجدت بكتريا النترجة بنوعيها النايتروسومونس 7 عزلة والنايتروبكتر 6 عزلة اذ ان أعداد بكتريا الازوتوباكتر والباسلس المثبتة للنتروجين بصوره حرة والمذيبة لمركبات الفوسفات في التربة تتواجد بوفرة في ترب رايزوسفير النباتات المختلفة المستخدمة في البحث في الحقول الزراعية المستدامة. وجد اعلى معدل للتنوع الحيوي للعزلات في حقل فلوجة نعيمية مساحة 12 هكتار المزروع فيها فلفل بمعدل 11 عزلة بينما اقل معدل بلغ 2 عزله في تربة حقل هيت بصاير المزروعة بالنخيل وبمساحة 5 هكتار. قدرت بعض الخصائص الفيزيائية والكيميائية وقدرت بعض العناصر الثقيلة ومعرفة تراكيزها لكل موقع اخذت منه عينات التربة والحصول على النتائج في مختبر كلية علوم

الحياة في جامعة بغداد وكانت اهم النتائج جميع العناصر المقدرة كانت ضمن المستوى الطبيعي والمسموح به عدا ارتفاع بسيط لتركيز الزنك 90 ملغم كغم−1 في حقل الصوفية 7 هكتار المزروع جت وارتفاع تركيز عنصر الرصاص 24.3 ملغم كغم −1 في حقل أبو غريب 80 هكتار ومزروعة بالقمح.

كلمات مفتاحية: مخصبات احيائية، عناصر ثقيلة، زراعة مستدامة، تنوع ميكروبي، رايزوسفير، تلوث.

Introduction

The Rhizosphere area in the soil is the area affected by the roots of plants, which is what we call the Rhizosphere. Also, in this area, the microbe's numbers change in quantity and quality by the presence of plant roots as a result of the influence of these microbes on the vital processes of the plant. The size of this area varies due to the type of plant and the nature of the plant root its size, its type, wedge, or capillary (6). indicates the presence of a dense community of microbes surrounding the roots, and on the surfaces of their external tissues and bristles. That bacteria spread in the form of chains and combinations, and it unlike other micro species affected by the root area and its numbers multiply in the soil which lies adjacent to Rhizoplane (11). The Scalar density of root microbes and the most microbe's combinations which respond clearly to the existence of plants in Cultivated or uncultivated soil (soil-free root) were in order: cells/gram of dry soil): Bacteria ($2.1 \times 10^{9} \times 10^{5}$): bacterial arc ($10^{9} \times 10^{5}$).

And he said that any material or energy in a natural environment that exists in its Abnormal quality, quantity, state or in the wrong place and time may harm living organisms or humans (6). Heavy metals: called toxic metals (Cd, Co, Cr. Cu, Fe, Hg. Mn. Mo, Ni, Pb. Zn) (8). Some of these Metals play an important role in the life of living things and their various biological activities. Iron has importance in the synthesis of blood and enzymes. Manganese, zinc, and copper are enzymatic catalysts. The danger of these Metals increases in the environment because of the inability to analyze them by bacteria and other natural processes, as well as their stability, which enables them to spread too far places from their origin or sources, and perhaps the most dangerous thing about it is its ability to bioaccumulation in the tissues and organs of living organisms in the water or land environment.

Microbial vaccines used in agricultural management practices can return the soil to its normal state (9). Despite treating soil microbes to improve crop productivity is an ancient practice, it is still undetected, especially concerning mechanistic studies of plant and microbe interactions and microbial persistence in heterogeneous communities in diverse locations, soils, and hosts13 (1).

The process of monitoring biomass and increasing the useful bacterial diversity in the soil environment has become very important, especially with the wrong and unjustified conditions in agricultural uses that harm soil health and lead to its deterioration and its exit from the agricultural sector. So, this study is a preliminary indicator for assessing the state of biomass in the most important agricultural sectors, the extent of their activity, and the variance of this will determine the reasons for the deterioration or success, which will allow the decision maker to act to treat the defect

and repair the vital system to maintain a safe and free pollution product. Agricultural lands show a high level of spatial contrast, including the contrast in chemical physics, soil properties, and agroecosystem management (1 and 10), which can influence the activity and The composition of organisms in the soil (4 and 12). Soil is a very complex system in which plants and microorganisms cooperate to obtain sources of water and nutrients and these forms of life cooperate along with soil to create constantly changing conditions (4). Microbial biomass is the basis and is the living part of soil organic material which is responsible for maintaining and improving soil quality (2). Heavy metals have an important role in the metabolic processes of living organisms, some are necessary as micronutrients such as cobalt, nickel, iron, chromium, and zinc (12), as they enter the reduction processes to stabilize molecules, and they work as catalysts in enzymatic reactions and osmotic balance regulation. Cadmium Mercury and lead have no vital role for living organisms, and they are considered harmful even in their low concentrations. In general, the concentrations of necessary and non-essential metals become toxic if they exist in low concentrations (11) This study aims to present results in this study, measuring the concentration and distribution of some heavy metals like cadmium, cobalt, lead, copper, and iron, as well as evaluating some of the biological, physical, and chemical properties of some agricultural fields in Anbar Governorate and their impact on bio -fertilizers.

Materials and Methods

Soil samples were collected root soil from different sites of agricultural fields in Al-Anbar planted with different crops (pepper, beans, alfalfa, barley, vegetables, tomato, wheat, and potatoes) and distributed in Fallujah. Ramadi, Muhammadi, Sufia, Khalidiyah, Saqlawiyah, Heet, and Abo-Ghraib to isolate Phosphate solvent and nitrogen fixer bacteria. The weight of the sample is 0.5-1.0 kg. The soil took from a depth of 2-20 cm from the soil surface after removing 2 cm from the surface. Soil samples were taken with a sterile tools, the soil was placed in sterile plastic bags, and information was recorded on it, and then transferred to the laboratory. The process of collecting samples lasts for 7 months from September 2021 to March 2022. Soil samples are placed at 4 ° C (In the refrigerator) until the isolation process starts. The process of isolating phosphate-dissolving bacteria is made by using decimal dilution and dish pouring technique (6), Pouring 1 ml of these dilutions into sterile Petri dishes into sterilize medium (5) at 121 ° C and 1.5- and in medium pressure for 15 minutes and then the dishes incubate at a temperature of 28 ± 2 for 72 hours in the incubator and to identify the phosphate - dissolving bacterial colonies which could be distinguished because it forms clear aura around it colonies as an indication to the dissolution of the formed phosphate precipitate (4) and the diameters of the transparent aura recorded.

Nitrogen-fixing isolates were isolated on a NFB medium, and the nitrogen-fixing colonies color yellow and isolates on Picoviskya medium and Macconkey phosphate–solubilizing bacteria isolates and stevnson medium Nitrosmonas and Nitrobacter bacteria isolates (7). The isolates were selected for colonies to dissolute phosphate compounds according to solubility diameter and they recultivated on Slant Nutrient

Agar to reuse in subsequent experiments. The isolated bacteria were identified in the Center of Food and Biotechnology and the Laboratories of the Ministry of Science and Technology (15). The tests included the characteristics of the culture. microscopic examinations and biochemical tests.

Ions of lead (Pb), cadmium (Cd), copper (Cu), iron (Fe), zinc (Zn), manganese (Mn), and nickel (Ni) were extracted according to the method (10). after good mixing and removing the stuck material and then grind with a ceramic mortar and passed through a sieve with a diameter of 64 microns, after then 2 g of each dry sample was weighed and placed in a Teflon beaker of 50 ml, and 85 ml of HCI and HNO_3 and then heated on a glass plate at 27 C. 4 ml of concentrated hydrofluoric and pyrochloric added and then evaporated till dryness, then separated by a centrifuge at a speed of (3000) cycles/min for 30 minutes. Then it was measured by FAAS (absorption atomic flame spectrophotometer) and examined according to (11). Some physical and chemical properties of soil are also estimated, including pH, electrical conductivity, phosphorous, nitrates, carbonates, and bicarbonates in the soil (13).

Results and Discussion

It was found that the soils selected from fields that were cultivated continuously for 33 to 25 years were characterized by a high average content of bacteria, ranging between 1.0×10^5 and 4.8×10^7 forming a colony of 1 gm of soil for the two sites of Al Buwaitha field and Al Sufia field in order. Those soils varied in the numbers and genera of the dominant bacteria (Table 1), as it found that the content of soluble bacteria of phosphate compounds was at a rate between low and medium it was 3.1×10^2 and 4.9×10^4 units of the colony and 1 gm soil $^{-1}$ for two sites Saqlawiyah, the site which cultivated with palms and Abu Ghraib, Omar farm which cultivated with alfalfa crop, in order. The soil content of Nitrogen - fixing bacteria varies, as the lowest rate was 6.3 x 10 2 and the highest rate was 5.2×10^4 colony forming units' gm soil^{-1} for the two sites of Fallujah Al Nuaimiya which is cultivated with pepper crop and Fallujah Amriya field which cultivated with alfalfa crop.

The results after isolation and test showed the type of isolates obtained from the soil and after microscopic diagnosis and the results of biochemical PCR tests found in Table 2, it was possible to obtain 74 different isolates of biofertilizers and 15 isolates of Azotobacter bacteria that were considered nitrogen free fixer in the soil, and 15 isolates of Bacillus bacteria that solvent of phosphate compounds in the soil, then comes Pseudomonas bacteria that dissolve phosphate compounds and biodegrade organic compounds at 11 and 10 isolates each of Streptomycetes that dissolve organic compounds and produces antibiotics and azosperlimes accompanying to the roots of plants and Nitrogen freely fixing while it found that the bacteria of Nitrogen exists in 7 isolates of Nitrosomycetes bacteria and 6 isolates of Nitrobacter bacteria.

It was also found that the Fallujah Al Nuaimiya field with an area of 12 hectares cultivated mostly pepper crop, and samples took on 20-10-2021, from which the highest rate of biodiversity from biofertilizers isolated reaching 11 isolates, followed by 8 isolates from Abu Ghraib fields, Nibras farm, with an area of 80 hectares

cultivated with wheat, and samples took on 15-12-2021, then Fallujah Al-Rahhaliyah field with an area of 40 hectares cultivated with Alfalfa, and samples took in 3-1-2022, it found that the lowest average of diversity was 2 or 3 to each isolation to Bassaer fields with 5 hectares cultivated with palm trees. And Fallujah Al Muhammadi with 22 hectares cultivated with palm trees and alfalfa.

It found that the nature and density of the dominant plants play role in certain species and types of bacteria dominance, in addition to that all environmental factors also affected the numbers and types of bacteria in the soil. Studies made on different types of soils and in different environmental conditions showed a dominance of some bacterial genera that can grow on culture media, unlike others that cannot endure these conditions. All soils may contain autotrophic bacteria and other contains organic bacteria, spore-forming, and non-forming bacteria, and also there is cellulose dissolving, sulfur-oxidizing, nitrogen-fixing, or reducing nitrate, sulfate, and ferric bacteria. According to obtained results, it can be observed the effect of the roots on t microbes of the root area, and there is a response of many microbes to root secretions more than they respond to the dead or decomposing plant tissues which contributes to the increase of the microbial community. It found that there is a decrease in microbe numbers in roots of corpus areas at the end of plant season in the last levels of growing levels (maturity stage) that means at the end of the season and this may have happened due to the rapid decomposition of materials and the consumption of carbohydrates, which results in a decrease in the number of microbes. Also, the spread of microbes in the root area differs according to the types of cultivated plants, and such differences are due to several factors such as the nature of the roots, their tissue composition, and the secretions produced by them (12).

Table 1 Number of totals and Dissolve bacteria of phosphate and nitrogen-fixing for each site (colony forming unit 1gm to soil).

Location	Microbial density	Number of soluble bacteria of p compositions	Number of nitrogen-fixing bacteria	Corps Type with sample	Size (Hectare)	Date of sample collecting
Al-Buwaitha	$^{5}10\times1.0$	$^{5}10\times1.0$	$^{4}10\times4.5$	Alfalfa	7	10-11-2021
Al-Ramadi , Al-Sufia	$^{7}10\times4.8$	$^{7}10\times4.8$	$^{3}10\times3.1$	Eggplant	4	12-10-2021
Abu-Gharib Nebras farm	$^{6}10\times2,0$	$^{6}10\times2,0$	$^{3}10\times3.2$	Wheat	80	15-12-2021
Abu-Gharib omar farm	$^{7}10\times2.4$	$^{7}10\times2.4$	$^{3}10\times8.8$	Alfalfa	7	15-11-2021
Abu-Gharib Kasim farm	$^{5}10\times2.2$	$^{5}10\times2.2$	$^{3}10\times4.2$	Bean	7	1-10-2021
Abu-Gharib farm 4	$^{7}10\times2.5$	$^{7}10\times2.5$	$^{4}10\times4.8$	Vegetables	7	22-12-2021
Amiriyah Fallujah 1	$^{6}10\times1.5$	$^{6}10\times1.5$	$^{4}10\times5.2$	Alfalfa	20	28-12-2021
Amiriyah Fallujah 2	$^{5}10\times6.7$	$^{5}10\times6.7$	$^{2}10\times3.9$	Potatoes	30	15-11-2021
Fallujah ALNuaimya	$^{7}10\times4.5$	$^{7}10\times4.5$	$^{2}10\times6.3$	Pepper	12	20-10-2021
Fallujah	$^{6}10\times2.0$	$^{6}10\times2.0$	$^{4}10\times3.2$	alfalfa	40	1-3-2022

ALRahaliah						
Al-Saqlawiyah	^{6} 10×2.3	^{6} 10×2.3	^{3} 10×4.8	Palm trees	40	9-10-2021
Fallujah Al-Muhammadi	^{5} 10 ×3.5	^{5} 10 ×3.5	^{3} 10×4.3	alfalfa, palm trees	22	18-2-2021
Heet Bassaer 1	^{6} 10× 2.2	^{6} 10× 2.2	^{3} 10×5.2	Palm trees	5	8-1-2022
Heet Bassaer 2	^{5} 10 ×5.1	^{5} 10 ×5.1	^{3} 10×3.6	citrus	4	8-3-2022

The results showed that the study of heavy metals in 14 sites differed when the cultivated field crops change of differing and with different environmental conditions and usage. It becomes clear that the highest concentration of zinc was 90.0 mg kg^{-1} in the Al-Sufia area for eggplant in Al-Anbar Governorate and the lowest concentration is 8.2 mg kg^{-1} for alfalfa crop in The Abu Ghraib area. The concentration for lead is 24.3 mg kg^{-1} for the wheat crop in Abu Ghraib area, and the lowest concentration is 10.8 mg kg^{-1} for the Alfalfa crop in the Amriyat Al-Fallujah area. The highest concentration of copper was 12.9 mg kg^{-1} for the eggplant crop in Sufia in Ramadi and the lowest concentration is 5.7 mg kg^{-1} for palm corps in Heet. The highest concentration of manganese is 302.4 mg kg^{-1} for the wheat crop in Abu Ghraib Nebras, and the lowest concentration is 151.2 mg kg^{-1} for the alfalfa and alfalfa crops in Abu Ghraib Omar and Amriyat Al-Fallujah. The highest concentration of Nickel is 7.5 For the wheat crop in Abu Ghraib, the lowest concentration was 1.7 mg kg^{-1} for the Alfalfa crop in Amriyat Al-Fallujah. Cobalt's highest concentration is 2.9 mg kg^{-1} for the potato crop in the Fallujah Amiriyah, and its lowest concentration is 0.87 mg kg^{-1} for citruses in the Heet Bassaer area. The Cadmium highest concentration is 0.22 mg kg^{-1} for palm crops in Saqlawiyah and the lowest concentration is 0.05 mg kg^{-1} for Alfalfa crop in Al-Buwaitha in Al-Ramadi and Amriyat Al-Fallujah. In the table 3. The results of the statistical analysis showed that there are no significant differences between the averages.

This does not mean that these percentages are fixed in the soils, and air pollution in these elements, throwing liquid wastes for industrial activities, or excessive use of chemical fertilizers and pesticides may cause an increase in the percentages of these elements. This requires land control and periodic and continuous inspection at regular periods.

Table 2 Isolations obtained after isolate and diagnosis from the site where samples were taken.

Location	Azotobacter	Azosopillium	psedomonas	Actenomycetes	Bacillus	Nitrosmonas	Nitrobacter	Total
Al-Buwaitha	**1**	**1**	**2**		**1**			**5**
Al-Ramadi , Al-sufia	**1**				**3**			**4**
Abu-Gharib Nebras farm	**1**	**1**		**1**	**1**	**2**	**2**	**8**
Abu-Gharib omar farm	**1**	**1**			**1**	**2**	**1**	**6**
Abu-Gharib Kasim farm	**1**		**1**		**1**	**1**	**1**	**5**
Abu-Gharib farm 4	**1**		**1**	**1**	**1**			**4**
Amiriyah Fallujah 1	**1**	**1**			**1**			**3**

Amiriyah Fallujah 2	**1**	**1**	**1**	**1**				**4**
Fallujah ALNuaimya	**1**	**1**	**3**	**2**		**2**	**2**	**11**
Fallujah ALRahaliah	**1**			**5**	**2**			**8**
Al-Saqlawiyah	**1**	**1**	**2**					**4**
Fallujah Al-Muhammadi	**1**				**2**			**3**
Heet Bassaer 1	**1**				**1**			**2**
Heet bass air 2	**1**	**2**			**1**			**4**
	15	**10**	**11**	**10**	**15**	**7**	**6**	**74**

Table 3 Study of heavy metals for sites from where soil samples taken.

Location	Zn ppm	Pb ppm	Cu ppm	Mn ppm	Ni ppm	Co ppm	Cd ppm
A 1	12.2	18.9	12.9	265.8	14.4	2.4	**0.05**
A2	17.0	24.3	17.7	302.4	18.5	3.5	**0.07**
A3	12.4	16.2	14.3	275.6	15.6	2.9	**0.1**
A4	8.2	16.1	7.2	151.2	5.0	1.3	**0.06**
A5	9.2	16.3	12.6	271.2	12.1	2.5	**0.15**
A6	9.2	10.8	6.9	151.2	4.7	0.87	**0.05**
A7	111.0	18.9	19.1	198.7	7.7	1.16	**0.1**
A8	20.7	18.8	16.6	254.9	15.3	2.0	**0.2**
A9	10.0	13.5	9.4	186.3	8.0	1.0	**0.11**
A10	14.6	18.9	13.7	272.7	12.0	2.04	**0.22**
A11	13.5	16.2	10.3	213.4	10.5	1.45	**0.15**
A12	9.6	16.1	5.7	177.6	7.1	1.16	**0.17**
A13	10.9	16.0	6.6	152.0	6.1	0.87	**0.12**
A14	13.4	13.5	8.9	244.0	7.9	1.0	**0.09**
LSD value	3.482 *	4.07 *	3.95 *	42.17 *	5.33 *	0.882 *	**0.113 ***

*** ($P \leq 0.05$).**

The results were compared according to parameters approved by the World Health Organization. The results matched permissible limits, except for cobalt and nickel. And it showed that there is a significant bond between cobalt and nickel concentration and its relationship to the presence of soil microorganisms and their numbers in the soil, cause any increase or decrease of cobalt and Nickel concentration, the microorganisms increase and decrease and thus affect its activity and numbers in the soil and that also effect on the plant. The result showed that any increase or decrease in cadmium, copper, manganese, lead, and zinc concentration the results showed that the increase and decrease in zinc, cadmium, copper, lead, and manganese do not affect the number and activity of vital fertilizers in the soil and therefore does not affect the numbers of bacteria and nutrients in the soil of the plant.

Some physical and chemical characteristics of soil samples (14 sites) were studied, as it included selected areas of Abu Ghraib, Al-Fallujah, Al-Ramadi and Heet. They included soil texture, electrical conductivity, soil interaction degree, and the percentage of organic material in physical and chemical properties. The results showed that there are no observed differences between fields, Except the increase in electrical conductivity to reach 7.42 ds m^{-1} in the field of Amriyat Al-Fallujah 1 cultivated with alfalfa to treat salinity and the high pH value in two sites, Saqlawiyah and Fallujah Al-Muhammadi which reached to 8.3 which are soils with a gypsum rate of 18.4% and cultivated palm and Alfalfa and mixing Alfalfa with palms. As for the organic material percentage, the highest value for Abu Ghraib 4 field, which is

cultivated with vegetables and fertilized with poultry field residues is 2.75%, followed by the soil of the Saqlawiyah site which is cultivated with palms and alfalfas and its percentage was 2.01%, while the lowest percentage of organic material in the field of Heet Bassaer which cultivated with palms was only 1.03%. The soil texture in the fields was similar in content to dust and clay and tended to light and medium textures. By observing the results, the values of soil interaction degree for the samples were very close, and this may be due to the lack of waste and organic fertilizers in recent years2. The results also showed that there is a discrepancy salinity rate in the soil (10).

Table 4 Correlation coefficient between micro - organism and parameters study.

Parameters	Correlation coefficient-r with micro-organism	P-value
Cd	0.45 NS	0.102
Co	0.54 *	0.043
Ni	0.51 *	0.049
Mn	0.36 NS	0.194
Cu	0.32 NS	0.264
Pb	0.40 NS	0.147
Zn	0.07 NS	0.798
OM	0.10 NS	0.718
PH	0.19 NS	0.504
EC	0.06 NS	0.834
Clay	0.32 NS	0.253
Silt	0.31 NS	0.278
Sand	0.34 NS	0.233

*(P≤0.05), NS: Non-Significant.

Table 5 Effect of Location on EC, pH, OM %, and Soil structure.

Location	EC dsm^{-1}	pH	O.M %	structure
Buwaitha	2.290	7.6	1.85	Silty clay loam
Al-sufia	2.700	6.9	1.8	Medium loam
Abu-Gharib Nebras	4.310	7.7	1.11	Sand clay
Abu-Gharib omar	3.590	7.9	1.83	Sandy loam
Abu-Gharib Kasim	3.530	8.1	1.15	Clay loam
Abu-Gharib 4	1.01	7.8	2.71	Medium loam
Amiriyah Fallujah 1	704	7.7	1.7	Medium loam
Amiriyah Fallujah 2	2.440	7.67	1.45	Silty clay
Fallujah ALNuaimya	2.950	7.7	1.54	Silty clay loam
Fallujah ALRahaliah	1.380	8.1	1.6	Silty clay loam
Saqlawiyah	1.870	8.3	1.16	Silty clay
Fallujah Al-Muhammadi	1.100	8.3	2.01	Medium loam
Heet Bassaer 1	1.950	7.8	0.86	Sandy loam
Heet Bassaer 2	2.590	7.9	1.71	Sandy clay loam
LSD	3.510 *	1.064 *	0.922 *	

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