The Effect of Bio, Organic Fertilization, and NPK Nano fertilizer on Some Soil Properties

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Abstract

An experiment was conducted in a citrus nursery in the Holy Governorate of Karbala / Hindiyah District belonging to the Ministry of Agriculture on local lemon seedlings to study the effect of adding bio fertilizer at four levels (0, Trichoderma, Mycorrhizal, Trichoderma + Mycorrhizal), the second factor is the addition of plant residues at three levels (0, 20, 40 $Mg.ha^{1}$), while the third factor was adding the NPK Nano fertilizer at three levels (0, 5, 10 Mg) on some soil properties. The experiment was implemented as a factorial experiment according to a randomized complete block design (RCBD) with three replicates. The average results were compared according to the least significant difference (L.S.D) test at the probability level of 0.05. Bio fertilization showed a significant effect on all the studied soil characteristics (soil reaction pH, salinity, exchange capacity CEC, organic matter, bulk density). Whereas organic fertilization behaves the same behaviour, NPK Nano fertilization showed a significant increase in the CEC. The dual interaction between the study factors had a significant effect on some traits, while the triple interaction, there was a significant effect on all the studied traits.

Keywords*:* Bio-fertilizer, Organic fertilizer, Nano fertilizer, Local lemon seedlings.

Introduction

In order to maintain plant productivity at the lowest possible cost when compared to other fertilizers, bio fertilizers primarily rely on the use of natural biological systems to process the essential nutrients for the plant without the need for harmful chemical fertilizers. At the same time, they are free of pollutants, ensuring the production of safe, healthy, and exportable food [10][11]. Any item created secondly or accidentally during crop production—during harvesting or during the process of getting ready for manufacture or marketing—is referred to as organic matter. That is, secondary materials from agricultural production processes are used to create clean energy, organic fertilizers, or fodder in order to protect the environment from pollution, promote clean agriculture, create jobs, and enhance agricultural output. As a result, the economic and environmental situations continue to improve [2] .According to [8] , Nanomaterials possess all the required qualities to be used in agriculture, including high solubility and effective concentration, good effectiveness, small dosages, avoidance of repeated additions to the plant, and subsequent good results from the initial addition, which increases fertilizer efficiency. Citrus limon L. Burm, or lemon trees, are members of the Rutaceae family, which is comprised of the citrus genus. This species originated in the areas of southwest China and north-eastern India. The indigenous citrus variety is one of the most sought-after types in Iraq due to its outstanding quality, small size, juicy, thin peel, and lower acidity % compared to other international kinds, making its fruits appealing [3] . The purpose of the experiment is to examine the effects of either single or combined bio, organic, and Nano fertilization on specific soil parameters.

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Materials and methods of work

Between January 4, 2023, and November 11, 2023, an experiment was carried out at a certified citrus multiplication nursery situated in Al-Hindiya District/Holy Karbala Governorate. The purpose of the experiment was to investigate the impact of NPK Nano fertilizer, plant residues, and bio fertilizer on certain soil properties. From approved citrus multiplication nurseries in the Hindiyah District/Holy Karbala Governorate, which are part of the Iraqi Ministry of Agriculture - General Directorate of Horticulture and Forestry, 324 homogeneous seedlings planted in 1,250 kg bags were chosen. On 1/4 /2023, they were moved to 5 kg pots. All necessary care was given to the seedlings, including weed control and irrigation as necessary, after they were planted under the canopy wrapped in green saran. Prior to the experiment commencing, a number of soil samples were collected, analysed , and the treatments for the experiment were implemented in order to determine the physical and chemical properties of the soil before sowing. With three seedlings for each experimental unit, the study was conducted as a factorial experiment (4*3*3) using a randomized complete block design (RCBD) and three replicates. The first factor represented bio fertilizers at four levels (0, Trichoderma 5 g, Mycorrhizal 5 g, and a mixture of Trichoderma and Mycorrhizal as a soil application at a rate of 10 g per one pot). The third element is the addition of N.P.K. Nano-fertilizer at three levels (0, 5, 10) mg, whilst the second factor is the addition of organic fertilizer at three levels (0, 20, 40 $Mg.ha^{-1}$). The first study element was bio fertilization (5 g of Trichoderma, 5 g of Mycorrhizal, or 5 g of a combination of Trichoderma and Mycorrhizal per pot) and the second was organic fertilization (60, 120 g without additives). NPK Nano fertilization (0, 5, 10 mg/pot) is the third factor. Prior to planting, organic fertilizer was applied by combining it with the soil and adding it to the pots meant for lemon seedlings. A week after seeding, bio fertilizer was also applied to the soil in the rhizosphere zone, close to the roots. A week after applying the bio fertilizer, or two weeks following the process of moving the lemon seedlings to the pots assigned to them, NPK Nano fertilizer was added, while the comparison treatment received only distilled water spraying. Statistical analysis software (SPSS) was utilized to analyses the data, and at the probability level of 0.05, the least significant difference (L.S.D.) test was used to compare the average results. The core sample approach was used in the field to estimate bulk density [5]. Using a pH meter and the procedure described in [9] , the (pH) was determined in the soil extract (1:1). However, the (CEC) Cations Exchangeable Capacity was determined by the sodium oxalate method as indicated in [4] , and the electrical conductivity (EC) was measured in saturated dough using a conductivity bridge device in accordance with the method of [9] . The approach described by [5] was used to estimate the organic matter.

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Table (1) Some chemical, physical, and biological properties and characteristics of the study soil before seeding

Characteristic		Value	unit
pH		7.8	-
Ec 1:1		3.51	ds m^{-1}
Cation exchange capacity (CEC)		17.31	Cmol+kg^{-1} soil
Organic matter		8.87	$g.kg^{-1}$
carbonate mineral		206	$g.kg^{-1}$
Available elements	Nitrogen	20.17	$mg.kg^{-1}$
	Phosphorus	8.21	
	Potassium	134.13	
	Iron	3.87	
	Zinc	0.88	
Soil separates	Sand	540	$g\ kg^{-1}$
	Silt	270	
	Clay	190	
Texture class		Loamy	
Bulk density		1.31Mg m^{-3}	
Mycorrhizal fungus (Glomus mosseae)		1 x 10^9	
Trichoderma fungus (Trichoderma Spp)		1 x 10^9	

Results and discussion

1- pH soil:

The bio fertilization treatment (Trichoderma + Mycorrhiza) gave the lowest average of 6.91 compared to the treatment 0, which gave the highest average of 7.67 with a significant decrease of 10.99%. Table (2) shows that there are significant differences in the effect of the studied factors on the (pH). With a substantial drop of 3.06%, the treatment 0 yielded the highest average of 7.39, while the treatment using organic fertilization, which included 120 g of organic fertilizer, was superior and delivered the lowest average of 7.17. Regarding the Nano-NPK fertilizer treatment, the treatment with 10 mg of Nano-NPK produced the greatest average (7.29) with a non-significant drop of 0.13% compared to the treatment 0, which produced the lowest average (7.28). Regarding the dual interaction between organic and biological fertilization, the treatment containing 120 g of organic fertilizer along with Trichoderma and mycorrhiza produced the lowest average of 6.80, a significant decrease of 14.26%, compared to the treatment containing no additions, which produced the highest average of 7.77. The same table's results also show that there are notable differences in the dual interaction between NPK Nano fertilizer and bio fertilization; among the treatments, the combination of Trichoderma + mycorrhiza + 10 mg of NPK Nano fertilizer produced the lowest average of 6.93, while the combination of fertilization 0 + 10 mg of NPK Nano fertilizer produced the highest average of 7.66, with a significant decrease of 11.01%. The treatment (120 g of organic fertilizer + without adding NPK Nano-fertilizer) produced the lowest average, amounting to (7.12), while the treatment (without adding organic fertilizer + 5 mg of NPK Nano-fertilizer) produced the highest average, amounting to (7.37) with a

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significant decrease of 3.51%. This indicates a dual interaction between organic fertilization and NPK Nano-fertilizer. However, there was a notable difference in the pH average (6.76) between the triple interaction treatment (Trichoderma + Mycorrhiza) + (120 g organic fertilizer + without adding NPK Nano-fertilizer) and the treatment (without adding bio fertilizer + without adding organic fertilizer + 5 mg of NPK Nano fertilizer), which produced the highest average (7.79) with a significant decrease of 15.23%.

Table 2: The impact of plant residues, NPK Nano fertilizer, and bio fertilization on the pH

Bio fertilization g.kg	Organic fertilization $Mg.h^{-1}$	Nano fertilization $kg.ha^{-1}$			Bio*organic fertilization
		0	5	10	
0	0	7.75	7.79	7.77	7.77
	20	7.68	7.65	7.66	7.67
	40	7.59	7.58	7.55	7.58
Trichoderma	0	7.52	7.51	7.55	7.53
	20	7.49	7.45	7.43	7.46
	40	7.10	7.34	7.39	7.28
Mycorrhiza	0	7.10	7.17	7.21	7.24
	20	7.08	7.11	7.06	7.08
	40	7.03	7.04	7.04	7.04
Trichoderma+ Mycorrhiza	0	7.02	6.99	7.01	7.01
	20	6.95	6.89	6.96	6.93
	40	6.76	6.81	6.83	6.80
LSD0.05		0.06			0.03
Bio * Nano fertilization					
0		7.67	7.67	7.66	7.67
Trichoderma		7.37	7.43	7.46	7.42
Mycorrhiza		7.15	7.11	7.10	7.12
Trichoderma+Mycorrhiza		6.91	6.90	6.93	6.91
LSD0.05		0.03			0.019
Organic * Nano fertilization					
0		7.41	7.37	7.39	7.39
20		7.30	7.28	7.28	7.29
40		7.12	7.19	7.20	7.17
LSD0.05		0.03			0.016
Average		7.28	7.28	7.29	
LSD0.05		NS			

2- Soil electrical conductivity (Ece) ds/m:

With a significant decrease of 80.95%, Table (3) shows that the studied factors' effects on the electrical conductivity differ significantly from one another. The bio fertilization treatment (Trichoderma + Mycorrhiza) produced the lowest average of 1.89 dS/m, while the treatment 0 produced the

highest average of 3.42 dS/m. The treatment with 120 g of organic fertilizer produced the lowest average (2.52 dS/m) of all organic fertilization treatment; in contrast, the treatment 0 produced the highest average (2.87 dS/m), indicating a substantial drop of 13.88%. The NPK Nano fertilizer treatment, which involved 10 mg of the fertilizer, produced the lowest average (2.70 dS/m) of any treatment. In contrast, the treatment without any addition produced the greatest average (2.71 dS/m), with a non-significant drop of 0.37%. The treatment containing Trichoderma + mycorrhizae and 120 g of organic fertilizer produced the lowest average of 1.64 dS/m in the dual interaction between bio and organic fertilization. In contrast, the treatment 0 produced the highest average of 3.49 dS/m, indicating a significant decrease of 112.80%. The results presented in Table (3) also demonstrate significant variations in the dual interaction between NPK Nano fertilization and bio fertilization. Specifically, the treatment containing both Trichoderma + mycorrhizae and 10 mg of NPK Nano fertilizer produced the lowest average of 1.86 dS/m, while the treatment containing no additions produced the highest average of 3.42 dS/m with a non-significant decrease of 83.87%. There was a notable distinction in the dual interaction between NPK Nano-fertilization and organic fertilization. In comparison to the treatment 0, which produced the greatest average, amounting to 2.87 dS/m with a substantial drop of 15.26%, the treatment (120 g organic fertilizer + 10 mg NPK Nano-fertilizer) yielded the lowest average, totalling to 2.49 dS/m. In contrast to the treatment (without adding bio fertilizer + without adding organic fertilizer + 5 mg NPK Nano fertilizer), which gave the highest average (3.50 dS/m), with a significant decrease of 116.04%, the triple interaction treatment (Trichoderma + Mycorrhiza) + (120 g organic fertilizer + 10 mg NPK Nano fertilizer) exceeded, which gave the lowest average degree of soil electrical conductivity (1.62 dS/m).

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Table (3) The effect of bio fertilization, plant residues, and NPK Nano fertilizer on the soil electrical conductivity (dS/m)

Bio fertilization g.kg	Organic fertilization $Mg.h^{-1}$	Nano fertilization $kg.ha^{-1}$			Bio*organic fertilization
		0	5	10	
0	0	3.48	3.50	3.50	3.49
	20	3.44	3.45	3.45	3.45
	40	3.32	3.33	3.31	3.32
Trichoderma	0	3.26	3.27	3.28	3.27
	20	3.04	3.04	3.04	3.04
	40	2.86	2.85	2.83	2.85
Mycorrhiza	0	2.64	2.62	2.63	2.63
	20	2.45	2.43	2.57	2.48
	40	2.34	2.25	2.19	2.26
Trichoderma+ Mycorrhiza	0	2.10	2.08	2.06	2.08
	20	1.96	1.95	1.89	1.93
	40	1.68	1.63	1.62	1.64
LSD0.05		0.071			0.041
Bio * Nano fertilization					
0		3.42	3.42	3.42	3.42
Trichoderma		3.05	3.05	3.05	3.05
Mycorrhiza		2.48	2.43	2.46	2.46
Trichoderma+Mycorrhiza		1.91	1.89	1.86	1.89
LSD0.05		0.041			0.024
Organic * Nano fertilization					
0		2.87	2.87	2.87	2.87
20		2.72	2.72	2.74	2.73
40		2.55	2.52	2.49	2.52
LSD0.05		0.010			0.020
Average		2.71	2.70	2.70	
LSD0.05		NS			

3- Bulk density $\mu g.m^{-3}$:

Table 4 shows that the factors that were studied had a significant impact on the bulk density of the soil; the bio fertilization treatment (Trichoderma + Mycorrhiza) outperformed the treatment 0, which produced the highest average amounting to 1.29 $Mg.m^{-3}$ with a significant decrease of 13.15%. The treatment with addition exceeded with the lowest average amounting to 1.14 $Mg.m^{-3}$. Regarding the treatment of organic fertilization, the treatment with 120 g of organic fertilizer produced the lowest average (1.20 $Mg.m^{-3}$), whereas the treatment 0 produced the highest average (1.29 $Mg.m^{-3}$), indicating a substantial 7.5% decline. In terms of NPK Nano fertilization, the treatment with 10 mg of NPK Nano fertilizer resulted in the lowest average, 1.23 $mg.m^{-3}$, as opposed to the treatment 0, which produced the highest average, 1.25 $mg.m^{-3}$, with a non-significant drop of 1.62%. The treatment consisting of Trichoderma + Mycorrhizae + 120 g of organic fertilizer yielded the lowest average in the dual interaction between biological and organic fertilization, measuring 1.12 $Mg.m^{-3}$.

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In contrast, the treatment 0 recorded the highest average, measuring 1.31 $Mg.m^{-3}$, with a significant decrease of 16.96%. The same table's results show that there are notable differences in the dual interaction between NPK Nano fertilization and bio fertilization. The treatment with 10 mg of NPK Nano fertilizer plus Trichoderma + mycorrhizae produced the lowest average of 1.13 mg/m^{-3}, while the treatment 0 produced the highest average of 1.30 mg/m-3, a significant decrease of 15.04%. In contrast, the treatment (120 g of organic fertilizer + 10 mg of NPK Nano-fertilizer) produced the lowest average (1.18 $Mg.m^{-3}$) in the dual interaction between organic fertilization and NPK Nano-fertilization, while the treatment (without adding organic fertilizer + 10 mg of NPK Nano-fertilizer) produced the highest average (1.39 $Mg.m^{-3}$) with a significant decrease of 17.79%. Trichoderma + Mycorrhiza + 120 g of organic fertilizer + 10 mg of NPK Nano fertilizer, the triple interaction treatment, exceeded, resulting in the lowest bulk density average (1.11 mg/m^{-3}). In contrast, the treatment 0 recorded the highest average (1.32 mg/m^{-3}) with a significant decrease of 18.91%.

Table (4) The effect of bio fertilization, plant residues, and NPK Nano fertilizer on the soil bulk density ($Mg.m^{-3}$)

Bio fertilization g.kg	Organic fertilization $Mg.h^{-1}$	Nano fertilization $kg.ha^{-1}$			Bio*organic fertilization
		0	5	10	
0	0	1.32	1.31	1.29	1.31
	20	1.31	1.29	1.27	1.29
	40	1.28	1.29	1.26	1.28
Trichoderma	0	1.26	1.27	1.24	1.26
	20	1.25	1.25	1.23	1.24
	40	1.23	1.24	1.20	1.22
Mycorrhiza	0	1.22	1.23	1.87	1.44
	20	1.20	1.20	1.17	1.19
	40	1.18	1.16	1.14	1.16
Trichoderma+ Mycorrhiza	0	1.17	1.18	1.15	1.17
	20	1.15	1.15	1.13	1.14
	40	1.13	1.13	1.11	1.12
LSD0.05		0.16			0.09
Bio * Nano fertilization					
0		1.30	1.30	1.27	1.29
Trichoderma		1.25	1.25	1.22	1.24
Mycorrhiza		1.20	1.20	1.39	1.26
Trichoderma+Mycorrhiza		1.15	1.15	1.13	1.14
LSD0.05		0.09			0.05
Organic * Nano fertilization					
0		1.24	1.25	1.39	1.29
20		1.23	1.22	1.20	1.22
40		1.21	1.21	1.18	1.20
LSD0.05		0.08			0.04
Average		1.23	1.22	1.25	
LSD0.05		NS			

4- Cations Exchangeable Capacity (CEC) $cmol+kg^{-1}$ soil:

Table 5 shows that the effects of the factors under study on the soil (CEC) differ

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significantly from one another. The bio fertilization treatment (Trichoderma + Mycorrhiza) produced the highest average (18.39 Cmol/kg) compared to the treatment 0 (17.31 Cmol/kg), which produced the lowest average with a significant increase of 6.23%.

Regarding the organic fertilization treatment, the treatment with 120 g of organic fertilizer produced the highest average amount (18.26 Cmol/kg) with a significant increase of 4.22% when compared to the treatment 0, which produced the lowest average amount (52 Cmol/kg). The NPK Nano fertilization treatment produced the highest average (18.00 Cmol/kg) of any treatment (10 mg of NPK Nano fertilizer) compared to the lowest average (17.87 Cmol/kg) of any treatment 0, with a non-significant rise of 0.72%. The treatment (Trichoderma + Mycorrhizae) + 120 g organic fertilizer produced the highest average amounting to 18.73 Cmol/kg in the dual interaction between biological and organic fertilization. This was in contrast to the treatment 0, which produced the lowest average amounting to 16.48 Cmol/kg, with a significant increase of 13.65%. The same table's results also show that there are significant differences in the dual interaction between NPK Nano fertilization and bio fertilization. The treatment with addition (Trichoderma + mycorrhizae + 10 mg of NPK Nano fertilizer) produced the highest average (18.45 Cmol/kg) compared to the treatment 0 (17.14 Cmol/kg), a significant increase of 7.64%. In addition, the treatment containing 120 g of organic fertilizer and 10 mg of NPK Nano-fertilizer produced the highest average amount of 18.32 Cmol/kg in the dual interaction between organic fertilization and NPK Nano-fertilization. This was significantly higher than the treatment containing no addition, which produced the lowest average amount of 17.49 Cmol/kg. In terms of soil exchange capacity, the triple interaction treatment (Trichoderma + Mycorrhiza) + (120 g organic fertilizer + 10 mg NPK Nano fertilizer) produced the highest average (18.85 Cmol/kg) and was superior to the treatment 0 (16.45 Cmol/kg), with a significant increase of 14.58%.

Table (5) The effect of bio fertilization, plant residues, and NPK Nano fertilizer on the cation exchange capacity (CEC) Cmol/kg

Bio fertilization	Organic fertilization	Nano fertilization kg.ha^{-1}	Bio*organic

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g.kg	$Mg.h^{-1}$	0	5	10	fertilization
0	0	16.45	16.49	16.50	16.48
	20	17.15	17.79	17.81	58
	40	17.84	17.85	17.89	17.86
Trichoderma	0	17.72	17.73	17.75	17.73
	20	17.82	17.88	17.91	17.87
	40	17.97	18.07	18.11	18.05
Mycorrhiza	0	17.94	17.96	17.99	17.96
	20	18.22	18.24	18.29	18.25
	40	18.34	18.38	18.43	18.38
Trichoderma+ Mycorrhiza	0	17.87	17.91	17.93	17.90
	20	18.48	18.52	18.58	18.53
	40	18.64	18.71	18.85	18.73
LSD0.05		0.170			0.098
Bio * Nano fertilization					
0		17.14	17.38	17.40	17.31
Trichoderma		17.84	17.89	17.92	17.88
Mycorrhiza		18.17	18.19	18.24	18.20
Trichoderma+Mycorrhiza		18.33	18.38	18.45	18.39
LSD0.05		0.098			0.057
Organic * Nano fertilization					
0		17.49	52	54	52
20		17.92	18.11	18.15	18.06
40		18.20	18.25	18.32	18.26
LSD0.05		0.085			0.049
Average		17.87	17.96	18.00	
LSD0.05		0.049			

5- Organic matter $g.kg^{-1}$ soil:

Table 6's results show that the effects of the factors under study on the organic matter differ significantly from one another. The bio fertilization treatment (Trichoderma + Mycorrhiza) produced the highest average of 9.45 $g.kg^{-1}$ soil, while the addition-free treatment produced the lowest average of 8.98 $g.kg^{-1}$ soil, a significant increase of 5.23%. Regarding the organic fertilization treatment, the treatment with 120 g of organic fertilizer produced the highest average amount of soil (9.32 $g.kg^{-1}$), a substantial increase of 3.67%, as compared to the treatment 0, which produced the lowest average amount of soil (8.99 $g.kg^{-1}$). Furthermore, with a non-significant increase of 0.21%, the NPK Nano fertilization treatment (10 mg of NPK Nano fertilizer) produced the greatest average of 9.20 $g.kg^{-1}$ soil compared to the treatment 0, which produced the lowest average of 9.18 $g.kg^{-1}$ soil. Regarding the daul interaction between organic and biological fertilization, the treatment containing 120 g of organic fertilizer along with Trichoderma and mycorrhizae produced the highest average amount of soil (9.69 $g.kg^{-1}$), significantly increasing it over the control treatment (8.91 $g.kg^{-1}$). The results in the table also show that there are notable differences in the dual interaction between NPK Nano fertilization and bio fertilization. With a significant

increase of 5.80%, the treatment with Trichoderma + mycorrhizae + 10 mg of NPK Nano fertilizer produced the highest average of 9.48 g.kg^{-1} soil, while the treatment 0 + 5 mg of NPK Nano fertilizer produced the lowest average (8.96 g.kg^{-1} soil). The treatment consisting of 120 g organic fertilizer and 10 mg NPK Nano fertilizer produced the highest average amount of soil (9.36 g.kg^{-1}), while the treatment 0 produced the lowest average amount of soil (8.99 g.kg^{-1} soil), with a non-significant increase of 4.11%. This indicates a dual interaction between organic fertilization and NPK Nano fertilization. While the treatment 0 recorded the lowest average (88.89 g.kg^{-1} soil) with a significant increase of 9.22%, the triple interaction treatment (Trichoderma + Mycorrhiza) + (120 g organic fertilizer + 10 mg NPK Nano fertilizer) exceeded, giving the highest average in the organic matter (9.71 g.kg^{-1} soil).

Table (6) Effect of bio fertilization, plant residues, and NPK Nano fertilizer on the organic matter (g.kg^{-1} soil)

Bio fertilization g.kg	Organic fertilization Mg.h^{-1}	Nano fertilization kg.ha^{-1}			Bio*organic fertilization
		0	5	10	
0	0	8.89	8.93	8.91	8.91
	20	9.08	8.97	8.97	9.01
	40	9.00	8.98	9.11	9.03
Trichoderma	0	8.96	8.94	8.97	8.96
	20	9.19	9.12	9.12	9.14
	40	9.20	9.16	9.17	9.18
Mycorrhiza	0	9.03	8.97	9.00	9.00
	20	9.23	9.28	9.28	9.26
	40	9.32	9.40	9.43	9.38
Trichoderma+ Mycorrhiza	0	9.09	9.11	9.12	9.11
	20	9.49	9.55	9.62	9.55
	40	9.66	9.71	9.71	9.69
LSD0.05		0.075			0.043
Bio * Nano fertilization					
0		8.99	8.96	8.99	8.98
Trichoderma		9.12	9.08	9.09	9.09
Mycorrhiza		9.19	9.21	9.24	9.21
Trichoderma+Mycorrhiza		9.41	9.45	9.48	9.45
LSD0.05		0.043			0.025
Organic * Nano fertilization					
0		8.99	8.99	9.00	8.99
20		9.25	9.23	9.24	9.24
40		9.29	9.31	9.36	9.32
LSD0.05		0.038			0.022
Average		9.18	9.18	9.20	
LSD0.05		0.022			

Discussion

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The effect of bio and organic fertilization and NPK Nano fertilizer on some soil properties

Tables (2, 3, 4, 5, and 6) showed a significant effect of bio fertilizers and bio fertilizers added to the soil in reducing the values of (pH, electrical conductivity, and bulk density) while the values of CEC and organic matter increased. The reason is due to the role of these fertilizers in the secretions and enzymes that they carry out inside the soil and its decomposition of organic matter, which leads to reducing the pH, salinity, and bulk density as a result of the extension of their hypha into the soil grains, which increases the porosity of the soil and improves its structure. While the CEC and organic matter values increase, where the organisms work on the decomposition of organic matter and thus increase the mineral elements, these elements will be in sites of replacement and exchange on the surface of the soil grains, and thus the cation exchange capacity increases. This is consistent with [6] , who emphasized that bio fertilizers improve the soil's physical and chemical characteristics and increase the availability of nutrients in the soil. As for the organic fertilizers added to the soil, they reduced the values of (pH soil , electrical conductivity, and bulk density), while the values of cation exchange capacity and organic matter increased. The reason for the decrease is due to the continuous decomposition of organic matter, which releases acids that work to reduce the aforementioned soil properties due to the chelation of positive ions and reducing their concentration in the equilibrium medium. In addition to the role of organic matter in improving the physical and chemical properties of the soil, including soil structure, bulk density, porosity, reducing salinity, and increasing the organic matter and cation exchange capacity as a result of increased microbial activity and the production of amino and organic acids due to the decomposition of organic matter in the soil, this is consistent with[7] . Organic matter also plays a role in improving the composition and characteristics of the soil and increasing the number of pores, it also has a low bulk density compared to the particle density of the soil, which leads to improving the physical properties of the soil, the most important of which is the bulk density[1].

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