The effect of inoculation with sulfur-oxidizing bacteria, agricultural sulfur, and rice husk extract on the concentration of sulfate in the soil during different incubation periods for (Zea mays L.) in saline soil.

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Abstract:
With the aim of identifying the efficiency of inoculation with the sulfur-oxidizing bacteria Thiobacillusthiooxidans (T) and the effect of adding it at levels with agricultural sulfur (S) and rice husk extract (RE) on the growth and yield of yellow maize zea MaysL in saline soils, the study was conducted in one of the agricultural fields affiliated with the Agricultural Research Station in Al-Muradiya District. In Al-Kifl district in Babil Governorate, the experiment was carried out in the agricultural fields of the research station to plant yellow corn for the fall season. Inoculation with bacteria (T) and adding levels of agricultural sulfur (S) and rice husk extract (RE) had a significant role in the concentration of (. SO4-2) available in the soil during the different growth periods (after 2 weeks, after 4 weeks, after 6 weeks, after 8 weeks, after 9 weeks) of germination. All additions of the single treatment (S2) achieved a significant effect on the concentration of sulfate in the soil. Its value was 548.2 mg SO4-2 kg soil-1 compared to the comparison treatment, which amounted to 145.2 mg SO4-2 kg soil-1. The binary intervention treatment (T2S2) for all treatments and levels achieved a significant effect in increasing the concentration of SO4-2 in the soil, which amounted to 623.5 mg SO4-2 kg soil-1 compared to The comparison treatment, which had a value of 133.4, mg SO4-2 kg soil-1 was superior to the triple intervention treatment T2S2RE2 and gave the highest value of 676.1 (mg SO4-2 kg soil-1). This increase was achieved during a period of 9 weeks from the plant and is the highest value for SO4-2 concentration.

Keywords: thiobacillusthiooxidans bacteria, agricultural sulfur, rice husk extract, sulfate, incubation materials.

Introduction:

The plant (Zea mays L.) belongs to the Poaceae family and is ranked second in importance after wheat, as it is considered one of the country's main and important grain crops, with high economic value. 50-55% of (Zea mays L) production is consumed . As food [1]... The element sulfur is one of the major and necessary elements for plants, as sulfur is found in the soil in both organic and inorganic forms. In most soils, organic sulfur is the main source of sulfur. Soils that contain decomposed plant waste have a high content of organic sulfur. The percentage of organic sulfur is (100%) of total sulfur, and it is divided into two parts: sulfur consisting of (Phenolic Sulpates) and (Choline Sulfur), and sulfur belonging to amino acids and fats, while inorganic sulfur consists of sulfates SO4-2 [2]. Sulfur purification wastes, such as pure sulfur (100%), foamed sulfur (75%), agricultural (90%), and other broad products can be used to increase the readiness of sulfur and other

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nutrients in the soil by reducing soil interaction and the formation of sulfuric acid as a result of biological oxidation. The oxidation process is carried out by A type of aerobic microorganism of the genus of bacteria (Thio bacillus Spp.) to compensate for the lack of nutrients. Sulfur is necessary in increasing crop production and growth, resisting fungal diseases, increasing the efficiency of nitrogen metabolism in the plant and other elements, and building amino acids (Cysteine) [3], [4].], [5]. Sulfur undergoes several transformations during the oxidation process in the soil, and these transformations are affected by the time of addition, the amount of addition, the amount of calcium carbonate, temperature, the size of the sulfur grains, the reaction of the soil, the presence of oxidizing bacteria, and the addition of organic matter.

Materials and working methods:

The field experiment was conducted in the fields of the agricultural research and experiments station in the Al-Muradiyah area of the Babylon Agriculture Directorate. Al-Muradiyah District, affiliated with Al-Kifl District, which is 20 km south of the city of Al-Hilla, the center of the governorate, and is located between longitudes 32-18 north and latitudes 44-23 east. Babil Governorate is considered a governorate specialized in growing the (Zea mays L.), where the field cleaning process was conducted and the experiment was carried out on the ground. Its area is 1081 m2 and its dimensions are 108m x 10m. The experimental site was plowed using a perpendicular plow, after which the adjustment and leveling process was carried out. The field was divided into three main sectors, with 27 experimental units within one sector. The area of the experimental unit is 6 m2 with dimensions of 2m x 3m, with three rows, the length of the row is 3m and the distance Between one stage and another is 0.75m [6], where sulphate is estimated by precipitation with barium chloride as in [7]. Rice husks (RE), which are rich in nutrients, were extracted using laboratory methods, as they contain multiple humic acids, It was prepared by taking 0.1 meter of KOH and a ratio (hulls of 10:1 distilled water) (Rice Residues: KOH), where it is Collect rice husks from the mills in the governorate, then wash them several times with plain water, wash them with distilled water well, and add the base KOH according to the recommended quantity. Shake the mixed materials containing the basic solutions for 24 hours with a shaker, then transfer them to the Centrifuge device for the purpose Separating the sediment from the filtrate, using the filtrate that has a dark walnut color, and adding the rice husk extract at a rate of (200, 100, 0) ml/m2, according to the recommended recommendations for each experimental unit, mixing with the surface layer to a depth of (0-20 cm)[8.[

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Chemical, physical and biological characteristics of the soil before planting

Property	Unit	the value
Electrical conductivity Ece Soil acidityPH Organic matter in the soil	ds/m^{-1} ------ %	7.9 7.8 0.50
negative dissolved ions Positive and		
Calcium	$Mmol\ l^{-1}$	17.89
magnesium	$Mmol\ l^{-1}$	10.03
Sodium	$Mmol\ l^{-1}$	22.85
Potassium	$Mmol\ l^{-1}$	0.82
Sulfates	$Mmol\ l^{-1}$	4.33
Chloride	$Mmol\ l^{-1}$	50.15
Bicarbonate	$Mmol\ l^{-1}$	Nill
Carbonate	$Mmol\ l^{-1}$	4.40
availablemade nutrients-		
Nitrogen	$mg\ kg\ soil^{-1}$	22.3
Phosphorus	$mg\ kg\ soil^{-1}$	7.21
Potassium	$mg\ kg\ soil^{-1}$	85.6
Soil crops		
sand	$gm\ kg\ soil^{-1}$	300
silt	$gm\ kg\ soil^{-1}$	610
Clay	$gm\ kg\ soil^{-1}$	90
Silty loam		**texture type**
Preparation of total bacteria	$CFUgdry\ \ Soil^{-1}$	2.6×10^6
Preparation of total fungi	$CFUgdry\ \ Soil^{-1}$	1.3×10^3
oxidizing -Preparation of sulfur bacteria	$CFUgdry\ \ Soil^{-1}$	1.1×10^3

Results and discussion

The effect of inoculation with levels of sulfur-oxidizing bacteria, levels of agricultural sulfur, and rice husk extract on the concentration of sulfate in the soil 2 weeks after germination:

The results of the statistical analysis in Table (1) showed that the unique treatment inoculated with sulfur-oxidizing bacteria significantly affected the concentration of bacteria and gave the highest value of the T2 treatment, which amounted to 271.5 (mg SO4-2 kg soil-1) compared to the comparison treatment. T0 and the second level treatment of adding inoculating bacteria, T1, where its value reached 238.1, 226.9 mg SO4-2 kg soil-1 -1. From the same table, when adding levels of agricultural sulfur, there was a significant effect on the concentration of SO4-2 , which gave the highest value of 381.7 (mg SO4-2 kg soil-1) in the single treatment S2. Compared to the comparison treatment S0 and the second level treatment of agricultural sulfur addition, S1, whose values reached 256.4 and 98.2, mg SO4-2 kg soil-1 respectively. The results of Table (1) showed that adding levels of rice husk extract had a significant effect on the concentration of sulphate in the soil after 2

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weeks of germination, as it outperformed the RE2 treatment and obtained the highest value of 266.9 mg SO4-2 kg soil-1 compared to the RE1 and RE0 treatment, which gave a value of 225.6 mg SO4-2 kg soil-1 and 243.9, mg SO4-2 kg soil-1 respectively. The statistical results of Table (1) show that the bilateral interaction between sulfur-oxidizing bacteria and sulfur levels significantly affected the sulfate concentration after 2 weeks of germination. The T2S2 binary intervention treatment was superior and gave the highest value of 425.4 mg SO4-2 kg soil-1 compared to the T0S0 and T1S1 treatments, which achieved a value of 249.7, 89.7 mg SO4-2 kg soil-1. Also, through the same statistical analysis table, the double interaction between the oxidizing bacteria and levels of rice husk extract had a significant effect on the concentration of SO4-2 in the soil. It was found that the double interaction treatment T2RE2 gave the highest value amounting to 297.8 mg SO4-2 kg soil-1 compared to the T0RE0 treatment and T1RE1 treatment, which gave a value of 258.3, 210.0 mg SO4-2 kg soil-1. It is clear from the results of Table (1) that the binary interaction between agricultural sulphur, its levels, and rice peel extract has a significant effect on the concentration of sulphate in the soil, as treatment S2RE2 achieved its highest value of 416.1 mg SO4-2 kg soil-1 compared to the comparison treatment S0RE0, which had a value of 92.0, mg SO4-2 kg soil-1 and the treatment of adding the medium level of peel extract. Rice S1RE1, which amounted to 278.7 mg SO4-2 kg soil-1. The highest value according to the results of statistical analysis was reached when the triple interaction between Thiobacillus bacteria, rice husk extract, and levels of agricultural sulfur had a significant effect on the concentration of SO4-2 in the soil 2weeks after germination. The triple intervention treatment T2S2RE2 achieved its highest value of 463.0 mg SO4-2 kg soil-1 compared to the comparative triple intervention treatment, which achieved a value of 82.7 mgSO4-2 kg soil-1.

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-1available sulfate concentration in the soil 2 weeks after germination) mg SO4-2 kg soil-1(

Sulfur bacteriaT	Agricultural sulfurS	Rice husk extractE			interaction T*S
		E0	E1	E2	
	S0	82.7	91.4	95.1	89.7
T0	S1	221.3	239.4	256.2	239.0
	S2	326.0	346.0	382.4	351.5
	S0	90.4	93.4	105.4	96.4
T1	S1	235.0	247.3	266.6	249.7
	S2	344.0	358.0	402.9	368.3
	S0	102.8	106.0	117.0	108.6
T2	S1	235.5	292.9	313.4	280.6
	S2	392.6	420.6	463.0	425.4
LSD 0.05		18.19			10.50
Sulfur bacteriaT		**T*E interference**			**T rate**
	T0	210.0	225.6	244.6	226.9
	T1	223.1	232.9	258.3	238.1
	T2	243.6	273.2	297.8	271.5
LSD 0.05		10.50			6.06
S rate		**S*E interference**			**Agricultural sulfur S**
	S0	92.0	96.9	105.8	98.2
	S1	230.6	259.9	278.7	256.4
	S2	354.2	374.9	416.1	381.7
LSD 0.05		10.50			6.06
E Extract an average		266.9	243.9	225.6	6.06

-2The effect of inoculation with levels of the bacteria thiobacillus thiooxidans, levels of agricultural sulfur, and levels of rice husk extract on the concentration of sulfate (SO4-2) after 4 weeks of germination:

The results of Table (2) in the single treatment of inoculation with sulfur-oxidizing bacteria showed a significant effect on the concentration of SO4-2 after 4 weeks of germination. The single treatment of the bacterial isolate T2 achieved its highest value, amounting to 292.3 mg SO4-2 kg soil, compared to the T1 and T0 treatment, which reached a value of 239.5 and 248.5 mg SO4-2 kg soil-1 respectively. The addition of agricultural sulfur, as shown in the same table, achieved a significant effect on the concentration of SO4-2 after 4 weeks of germination. Through the results of statistical analysis, the single treatment S2 achieved its highest value, amounting to 401.4 mg SO4 kg of soil, compared to the treatments S1 and S0, whose value reached 105.0. And 274.3 mg SO4-2 kg of soil. Adding levels of rice husk extract had a significant effect in increasing the concentration of SO4-2, as the single treatment RE2 outperformed and achieved a value of 284.2 mg SO4-2 kg of soil compared to the control treatment RE0 and the RE1 treatment, which had a value of 239.5. 257.1 mg SO4-2 kg soil-1. The dual interaction between adding levels of sulfur-oxidizing bacteria and levels of agricultural sulfur also

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had a significant effect on the concentration of sulphate in the soil. According to the results of Table 6, the T2S2 treatment outperformed the dual interaction and achieved the highest value of 451.2 mg SO4-2 kg soil-1 Compared to the intervention treatment (comparison) and T1S1, which achieved values of 95.5 and 382.2 mg SO4-2 kg soil-1 as well as the effect of the binary interaction between the bacteria Thiooxidans. t and rice husk extract significantly increased in SO4-2 concentration after 4 weeks of germination. The T2RE2 treatment excelled and gave the highest value of 317.6 mg SO4-2 kg soil-1compared to the comparison equation T0RE0 and the T1RE1 treatment, which gave a value of 223.6 mg SO4-2 kg soil-1 and 275.3, mg SO4-2 kg soil-1 respectively. The case of binary interaction between agricultural sulfur levels and levels of rice husk extract had a significant effect on the sulfate concentration after 4 weeks. The double interference treatment, according to the results of Table (2), outperformed the S2RE2 treatment and achieved a value of 442.2 mg SO4-2 kg soil-1 compared to the S0RE0 treatment and the S1RE1 treatment, which achieved a value of 96.5 and 296.2 mg SO4-2 kg soil-1. The triple interference treatment was achieved as shown by the results of the statistical analysis in Table (2). A significant effect when adding levels of sulfur-oxidizing bacteria, levels of sulfur-oxidizing bacteria, levels of agricultural sulfur, and rice husk extract on the concentration of sulfate in the soil. The triple intervention treatment T2S2RE2 achieved the highest value of 490.2 mg SO4-2 kg soil -1 compared to the comparison treatment T0S0RE0 and the T1S1RE1 treatment, which achieved a value of 90.0 and 280.5 mg SO4-2 kg soil-1.

-2available sulfate concentration in the soil 4 weeks after germination (mg SO4-2 kg soil-1(

Sulfur bacteriaT	**Agricultural sulfurS**	**extract Rice huskE**			**interaction T*S**
		E0	**E1**	**E2**	
	S0	90.0	93.2	103.3	95.5
T0	**S1**	243.0	250.1	272.4	252.2
	S2	346.8	362.9	403.0	370.9
	S0	94.4	103.3	112.0	103.3
T1	**S1**	242.6	260.7	280.5	261.3
	S2	332.1	381.0	433.4	382.2
	S0	105.0	116.8	127.0	116.3
T2	**S1**	288.5	304.4	335.7	309.5
	S2	422.2	441.1	490.2	451.2
LSD 0.05		19.43			11.22
Sulfur bacteriaT		**T*E interference**			**T rate**
	T0	223.6	235.4	259.6	239.5
	T1	223.0	248.3	275.3	248.9
	T2	271.9	287.4	317.6	292.3
LSD 0.05		11.22			6.48
S rate		**S*E interference**			**Agricultural sulfur S**
	S0	96.5	104.4	114.1	105.0

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	S1	255.0	271.7	296.2	274.3
	S2	367.0	395.0	442.2	401.4
LSD 0.05		11.22			6.48
E Extract an average		239.5	257.1	284.2	6.48

The effect of inoculation with levels of sulfur-oxidizing bacteria, levels of agricultural sulfur, and levels of rice husk extract on the concentration of 〖So〗_4^(2-) after 6 weeks of germination:

Table(3) shows that the single treatment, inoculation with the sulfur-oxidizing bacterial isolate, has a significant effect on the concentration of sulfate in the soil. The single treatment T2 achieved the highest value of 329.0mg 〖So〗_4^(2-)kg soil-1 compared to the following comparison T0 and comparison T1, whose value was 285.6 and 273.1 mg 〖So〗_4^(2-)kg soil-1. Adding levels of agricultural sulfur to the experimental units had a significant effect on the sulfate concentration after 6 weeks of germination. Through the results of Table (3), we note the superiority of the single treatment S2 and achieved the highest value amounting to 461.4 mg 〖So〗_4^(2-)kg.Soil-1 compared to the comparison treatment S0 and treatment S1, which achieved a value of 306.6, 119.7 mg 〖So〗_4^(2-)kg soil-1. The results of the statistical analysis in Table (3) also showed a significant effect on the single treatment, rice peel extract The concentration of bacteria in the soil 6 weeks after germination. The RE2 treatment obtained the highest value, amounting to 324.5, mg SO4-2 kg soil-1 compared to the values of the comparison treatment RE0 and the RE1 treatment, which achieved values of 292.5 and 270.8 mg 〖So

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〗_4^(2-)kg soil-1, as indicated by the analysis results The same statistics showed when treating the binary interaction between the isolation of sulfur-oxidizing bacteria and their levels, and the levels of agricultural sulfur, a significant effect on the concentration of 〖So〗_4^(2-)in the soil after 6 weeks of germination. According to Table(3), the double interference treatment T2S2 excelled and achieved the highest value of 521.10 mg 〖So〗_4^(2-)kg soil-1 compared to the comparison treatment T0S0 and the T1S1 treatment, whose value reached 299.5, 109.1 mg 〖So〗_4^(2-)kg of soil-1. Adding levels of the bacterial isolate Thiobacillusthiooxidanas and levels of rice husk extract had a significant effect on the concentration of sulfate in the soil. Through the results of the same statistical analysis, the binary interference treatment T2RE2 excelled and achieved the highest value of 367.4 mg 〖So〗_4^(2-)kg soil-1 compared to the comparison treatment T0RE0 and the T1RE1 treatment, which achieved a value of 310.9, 254.6. mg SO4-2 kg soil-1 Table (3) shows The binary interaction between adding levels of agricultural sulfur and levels of rice husk extract had a significant effect on the concentration of sulfate in the soil. The S2RE2 equation reached the highest value of 510.5 mg 〖So〗_4^(2-)kg soil-1 compared to the comparison treatment S0RE0 and the S1RE1 treatment, whose value reached 336.2, 113.1

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mg 〖So〗 _4^(2-)kg soil-1. Through the same table, the results of the triple interaction between the sulfur-oxidizing bacterial isolate and components of agricultural sulfur and rice hulls showed a significant effect on the concentration of 〖So〗 _4^(2-)after 6 weeks of germination through the superiority of the triple interaction treatment T2S2RE2, which gave the highest value amounting to 593.0. mg 〖So〗 _4^(2-) kg soil-1 compared to the control treatment, which amounted to 104.2 mg 〖So〗 _4^(2-) kg soil-1.

-3Ready sulphate concentration in the soil 6 weeks after germination mg 〖So〗 _4^(2-)kg soil-1

-3**available sulphate concentration in the soil 6 weeks after germination mg 〖So〗 _4^(2-) kg soil-1**

Sulfur bacteriaT	**Agricultural sulfurS**	**Rice husk extractE**			**interaction T*S**
		E0	**E1**	**E2**	
	S0	104.2	108.6	114.7	109.1
T0	**S1**	266.9	285.6	308.7	287.1
	S2	392.6	414.6	462.2	423.1
	S0	111.1	117.1	124.0	117.4
T1	**S1**	272.9	293.2	332.4	299.5
	S2	410.9	432.7	476.2	439.9
	S0	123.9	132.6	141.4	132.6
T2	**S1**	290.2	341.8	367.6	333.2
	S2	464.2	506.2	593.0	521.1
LSD 0.05		20.95			12.10
Sulfur bacteriaT		**T*E interference**			**T rate**
	T0	254.6	269.6	295.0	273.1
	T1	265.0	281.0	310.9	285.6
	T2	292.8	326.9	367.4	329.0
LSD 0.05		12.10			6.98
S rate		**S*E interference**			**sulfur Agricultural S**
		113.1	119.4	126.7	119.7
		276.7	309.9	336.2	306.6
		422.6	451.2	510.5	461.4
LSD 0.05		12.10			6.98
E Extract an average		270.8	292.5	324.5	6.98

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The effect of inoculation with levels of sulfur-oxidizing bacteria, levels of agricultural sulfur, and levels of rice husk extract on the sulfate concentration 〖So〗 _4^(2-) after 8 weeks of germination:

The results are shown in Table (4): The effect of inoculation with the sulfur-oxidizing

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bacterial isolate had a significant effect on the concentration of sulfates in the soil after 8 weeks of germination. The results showed that the affected treatment was superior to the T2 treatment and obtained the highest value amounting to 398.9 mg 〖So〗 _4^(2-) kg soil-1 Compared with the control treatment T0 and treatment T1, which achieved a value of 349.1, 329.1 mg 〖So〗 _4^(2-)kg soil-1. When adding levels of agricultural sulfur had a significant effect on the concentration of sulfate in the soil, through the results of the statistical analysis table (4), we notice the superiority of the unique treatment S2, which gave the highest value of 550.1 mg SO4-2 kg soil-1 compared to the comparison treatment S1, S0, which gave a value of 386.2, 140.9 mg 〖So〗 _4^(2-)kg soil-1. The results of the same analysis show that adding levels of rice husk extract significantly affected the concentration of sulfate in the soil. The results showed that treatment RE2 was superior and gave the highest value of 383.3 mg 〖So〗 _4^(2-)kg soil-1 compared to the comparison treatment RE1, RE0, which achieved a value of 362.3, 331.6 mg 〖So〗 _4^(2-)kg soil -1. The binary interaction between adding levels of the T.thiooxidanas isolate and levels of agricultural sulfur achieved a significant effect on the concentration of sulfate in the soil. Note from Table (4) that the T2S2 treatment was superior to the binary interaction, achieving the highest value of 618.5 mg SO4-2 kg soil-1 compared to the comparison treatment T0S0 and the T1S1 treatment, which achieved a value of 129.4, 389.3 mg 〖So〗 _4^(2-)kg soil-1. The results of the same statistical analysis table also showed the effect of the binary interaction between the bacterial isolate and levels of rice husk extract, a significant effect on the concentration of 〖So〗 _4^(2-)in the soil 8 weeks after germination. According to the results, the T2RE2 treatment excelled and gave the highest value amounting to 431.2 mg SO4-2 kg soil-1 measurements. With the T0RE0 treatment and the T1RE0 treatment, they achieved values that reached 363.2, 305.4 mg 〖So〗 _4^(2-)kg soil-1. The binary interaction between agricultural sulfur and rice husk extract had a significant effect on the sulfate concentration after 8 weeks of germination, and according to the results of Table (4), the results showed the superiority of the binary interaction treatment S2RE2 and gave the highest value of 593.1 mg 〖So〗 _4^(2-)kg soil-1 compared with the control treatment S0RE0 and treatment S1RE1, which achieved values of 405.9 and 130.8 mg 〖So〗 _4^(2-)kg soil-1. The triple interaction between the levels of the sulfur-oxidizing bacterial isolate, levels of agricultural sulfur, and levels of the extract achieved a significant effect on the concentration of 〖So〗 _4^(2-)after 8 weeks of germination.

The triple intervention treatment T2S2RE2 achieved the highest value of 672.1 mg 〖So〗 _4^(2-) kg soil-1 compared to the comparison treatment T0S0RE0, which achieved a value of 120.6 mg 〖So〗 _4^(2-)kg soil-1.

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:-4**available sulphate concentration in the soil 8 weeks after germination mg 〖So〗_4^(2-) kg soil-**1

Sulfur bacteriaT	Agricultural sulfurS	Rice husk extractE			interaction T*S
		E0	E1	E2	
T0	**S0**	120.6	128.1	139.3	129.4
	S1	322.3	345.9	373.8	347.3
	S2	473.3	504.8	553.6	510.6
T1	**S0**	129.0	137.3	145.2	137.2
	S1	340.0	437.2	390.8	389.3
	S2	489.3	520.5	553.4	521.1
T2	**S0**	142.8	157.1	168.4	156.1
	S1	389.4	423.4	453.2	422.0
	S2	577.4	606.1	672.1	618.5
LSD 0.05		42.95			24.80
Sulfur bacteriaT		**T*E interference**			**T rate**
	T0	305.4	326.2	355.6	329.1
	T1	319.4	365.0	363.2	349.2
	T2	369.8	395.5	431.2	398.9
LSD 0.05		24.80			14.32
S rate		**S*E interference**			**Agricultural sulfur S**
	S0	130.8	140.9	151.0	140.9
	S1	350.6	402.1	405.9	386.2
	S2	513.3	543.8	593.1	550.1
LSD 0.05		24.80			14.32
E Extract an average		331.6	362.3	383.3	14.32

-5The effect of inoculation with levels of the bacterial isolate (Thiobacillusthiooxidanas), levels of agricultural sulfur, and levels of rice hull extract on the sulfate concentration 〖So〗_4^(2-) after 9 weeks of germination:

Table (5) shows that the unique treatment has a significant effect of the isolation of sulfur-oxidizing bacteria on the remaining sulfate concentration 〖So〗_4^(2-)after 9 weeks of germination. The unique treatment T1 was superior and gave the highest value of 405.3 mg 〖So〗_4^(2-)kg. Soil-1 compared to the control treatment T0 and treatment T1, whose value was 340.1, 326.3 mg 〖So〗_4^(2-) kg soil-1. The results of the statistical analysis of the same table showed that adding levels of agricultural sulfur significantly affected the concentration of 〖So〗_4^(2-)after 9 weeks of germination. The unique treatment S2 excelled and gave the highest value of 548.2 mg 〖So〗_4^(2-)kg soil-1 compared to the comparison treatment S0 and treatment S1, which achieved values of 378.3, 145.2 mg 〖So〗_4^(2-)kg soil-1. Levels of rice husk extract also significantly affected the concentrations of 〖So〗_4^(2-) 9 weeks after germination. Through the results of Table (5), in which the unique treatment RE2 demonstrated its superiority and gave the highest value of 390.2 mg SO4-2 kg soil-1 compared to the comparison treatment, which gave a value of 328.1 mg 〖So〗_4^(2-)kg soil-1, and the RE1 treatment, which gave a

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value of 353.4 mg. So_4^{2-} soil-1. There was also an effect of the double interaction between inoculation with the isolate and adding levels of agricultural sulfur, and its effect was significant on the concentration of So_4^{2-}after 9 weeks of germination.

The results of the statistical analysis were also shown in Table (5), in which the T2S2 treatment outperformed and obtained the highest value of 623.5 mg SO4-2 kg soil-1 compared to the comparison treatment T0S0 and the T1S1 treatment, whose value reached 356.5, 133.4 mg So_4^{2-}kg soil-1. It was shown from the same table that the double interaction treatment between sulfur-oxidizing bacteria and levels of rice peel extract significantly affected the sulfate concentration after 9 weeks of germination, as the double interaction treatment T1RE1 outperformed and obtained the highest value of 437.3 mg SO4-2 kg soil-1 compared to the comparison treatment T0RE0 and the T1S1 treatment, which obtained a value They reached 372.8 and 292.4 mg So_4^{2-}kg soil-1. The results of Table (5) also showed the bilateral interaction between the effect of adding levels of agricultural sulfur and rice husk extract, and the effect was significant in increasing sulfate concentrations in the soil 9 weeks after germination. The binary intervention treatment S2RE2 achieved the highest value of 603.8 mg So_4^{2-}kg soil-1 compared to the comparison treatment S0RE0, which achieved a value of 135.1 mg So_4^{2-}kg soil-1. And the S1RE1 treatment, which achieved a value of 409.5 mg So_4^{2-}kg soil-1. The triple interaction of the experimental factors achieved a significant effect when adding levels of the bacterial isolate Thiobacillusthiooxidanas, levels of agricultural sulfur, and the level of rice hulls on the sulphate concentration So_4^{2-}after 9 weeks of germination. Through statistical analysis and the results of Table (5), the triple intervention treatment T2S2RE2 outperformed and gave the highest value of 676.1 mg So_4^{2-}kg soil-1 compared to the comparison treatment T0S0RE0, which gave a value of 123.0 mg So_4^{-2} kg soil. -1 .

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-5**available sulfate concentration in the soil 9 weeks after germination mg 〖So〗 _4^(2-) kg soil-1**

Sulfur bacteriaT	Agricultural sulfurS	Rice husk extractE			interaction T*S
		E0	E1	E2	
T0	S0	123.0	132.1	145.2	133.4
	S1	321.3	343.7	383.5	349.5
	S2	432.8	502.7	552.6	496.0
T1	S0	130.4	135.6	150.4	138.8
	S1	329.0	355.3	385.2	356.5
	S2	480.4	511.8	582.7	525.0
T2	S0	151.7	162.4	176.2	163.4
	S1	402.6	424.4	459.8	428.9
	S2	581.5	613.0	676.1	623.5
LSD 0.05		17.25			9.96
Sulfur bacteriaT		**T*E interference**			**T rate**
	T0	292.4	326.2	360.4	326.3
	T1	313.3	334.2	372.8	340.1
	T2	378.6	399.9	437.3	405.3
LSD 0.05		9.96			5.75
S rate		**S*E interference**			**Agricultural sulfur S**
	S0	135.1	143.4	157.3	145.2
	S1	351.0	374.4	409.5	378.3
	S2	498.2	542.5	603.8	548.2
LSD 0.05		9.96			5.75
E Extract an average		328.1	353.4	390.2	5.75

The statistical tables (1, 2, 3, 4, 5) indicated the effect of levels of sulfur isolate T.thiooxidanas and the addition of levels of agricultural sulfur and levels of rice husk extract. We noticed that all treatments and added levels and their interactions had a significant effect on the concentration of ready sulfates in the soil during the periods. different. It is noted that inoculation with isolated bacteria has a significant effect in increasing the values of sulfate in the soil compared to the value of the comparison treatment. This may be attributed to the fact that inoculation with sulfur-oxidizing bacteria leads to the readiness of sulfur in the soil because they oxidize incompletely oxidized sulfur compounds to sulfate 〖So〗 _4^(2-).[9] These results agreed with the findings of [10] which is that inoculation with oxidizing bacteria caused an increase in the amount of specialized sulfates by yellow maize plants. Adding agricultural sulfur levels had a significant effect on increasing sulfate in the soil for the different measurement periods. It was observed through the results of statistical analysis that ready-made sulfate in the soil increased with an increase in the levels of added sulfur for all measurement periods. This is attributed to an increase in the oxidation of sulfur and its compounds to sulfate 〖So〗 _4^(2-)Due to physical, chemical and

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biological factors, and all of these results are consistent with what he reached [11]. The results of statistical analysis showed that adding plant extracts, including rice husk extract, led to a significant increase in the concentration of ready-made sulfur in the soil compared to the control treatment. The reason for this is that the rice husk extract contains humic and glycolic acids, which increase the readiness of nutrients. They have led to an increase in the concentration of sulphates in the soil, in addition to the role of humic acids in improving soil structure and increasing the efficiency of the roots in absorbing water and nutrients in the soil and plants, in addition to Increasing the ability of the soil to retain water and nutrients [12]. Also, the interaction between rice husk extracts and agricultural sulfur had a significant effect in increasing the readiness of sulfates. The combined role of sulfur and rice husk extracts is due to increasing the sulfur concentration in the soil [12]. expressed [13] the importance of adding organic extracts, including rice husk extract, which contains humic acids and their ability to increase the survival and storage period of inoculations and bacterial isolates, encouraging growth for a longer period and using them for future uses. Many studies have also indicated the ability of humic substances to inhibit the growth of pathogenic bacteria. And stimulating the growth of estimated bacteria, as increasing the addition of levels of rice husk extract and the humic substances it contains reduces the activity and effectiveness of plant-pathogenic bacteria and increases the activity of beneficial bacteria for the soil and plants [14]. The effect of the bilateral interaction between inoculation with the bacterial isolate and levels of agricultural sulfur was significant in increasing the values of ready sulfate in the soil. The reason is due to the process of biological oxidation of sulfur by the bacterial isolates Thiobacillusthiooxidanas and the production of the bacteria. This is because the bacteria T.thiooxidanas has the ability to oxidize incompletely oxidized sulfur compounds to sulfate. [15]. This was consistent with the study concluded by [16]. , [17]. Bacteria have a role in biologically oxidizing agricultural sulfur, reducing soil reactivity, and increasing the solubility of compounds containing sulfur, thus increasing the readiness of 〖So〗_4^(2-)in the soil. The triple interaction between sulfur-oxidizing bacterial isolates, levels of agricultural sulfur, and levels of rice husk extract had a significant effect in increasing the concentration of sulfate in the soil for all previous measurement periods. It also showed the results of the table the cumulative amount of sulfate during the periods of taking the different models and the trend of sulfate release resulting from biological oxidation of sulfur processes over time, as we concluded from the results of the statistical tables (1, 2, 3, 4, and 5). the highest increase occurred in the amount of sulfate released after 6 weeks of germination. These results are consistent with the findings of [18] that sulfur has two stages of biological oxidation, which is slow oxidation for a period of 28 days followed by rapid oxidation, which leads to an increase in the release of sulfates in the first stages of growth and germination, but with the passage of time the amount of the increase decreases with the period of time and half of the added amount disappears. In 57 days.

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