The effect of adding chelated zinc and vermicompost on the readiness of some nutrients

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Abstract

A field experiment was conducted on yellow corn crop in the field of the College of Agriculture of the University of Babylon during the fall season 2022 to study the effect of adding chelated zinc and vermicompost and the interaction between them on the readiness of some nutrients according to the RCBD design. The experiment included two factors, the first factor is the addition of chelated zinc with three levels (0, 5, 10) kg H^{-1} and the second factor is the addition of vermicompost with three levels (0, 10, 20) tons H^{-1} and with three repetitions, so the number of experimental units became 27 units and then The seeds of yellow corn were sown, and the results were as follows:

1- The addition of chelated zinc to treatment Z_2 gave the highest availability of the macronutrients nitrogen, phosphorus and potassium available in the soil and the available zinc also amounted to 46.78, 29.50, 219.95 and 7.18 mg kg^{-1} soil sequentially.
2- The addition of vermicompost to the F_2 treatment gave a higher availability of the nutrients in the soil represented by nitrogen, phosphorus and potassium, as well as an increase in the availability of zinc in the soil (mg^{-1} soil).
3- The Zn_2F_2 binary interaction treatment excelled by giving the highest availability of nutrients in the soil represented by nitrogen, phosphorus, potassium and zinc as it reached 56.17, 35.92, 245.82 and 8.15 mg kg^{-1} soil respectively.

Introduction

Zinc is considered one of the essential microelements that plants need, as its deficiency leads to a significant deterioration in the crop, as it plays a major role in many physiological functions, as it plays a role in the formation of tryptophan It is an amino acid composed of indole acetic acid (IAA), which is important for cell elongation and stalk, as it stimulates the building of the ytochrome, as well as its role in stabilizing parts of the ribosome (1). The availability of zinc and many other microelements is affected by many soil-specific physico-chemical factors, including the pH of the soil solution and its chelate content. In order to overcome the degradation associated with the addition of minerals, chelated and micronutrient fertilizers were synthesized (2).

Biofertilizer technologies are among the modern methods used to reduce the risks of excessive use of mineral fertilizers, improve soil properties, and reduce production costs. The vital soil contents were not limited to plants and microorganisms, but also very important .aggregates such as earthworms, which are among the largest agents in the decomposition of organic matter. They are multi-species annular organisms that live in the soil of temperate and tropical regions, and their presence is evidence of their fertility for their role in improving the chemical and physical properties of the soil by digging tunnels while carrying out their importance, which enhances the penetration of roots and increases the porosity of the soil (3). Vermocompost is one of the most important fertilizers based

ISSN 2072-3857

on the recycling of organic waste, as it is an environmentally friendly process. Therefore, vermocompost has been shown to have several positive effects on plant growth and health (4).

The yellow corn crop is considered one of the important economic crops, due to its nutritional value in feeding poultry, and I considered that the corn crop is confined, fast in growth, as well as abundant in production, in a period not exceeding three months of growth, it can give fodder exceeding 70 tons H^{-1} (5) .

Materials and methods

A field experiment was carried out in the field of the College of Agriculture of the University of Babylon in the fall season of 2022 to find out the effect of adding chelated zinc and vermicompost and the interaction between them on the readiness of some nutrients in silt clay soil. The experiment included two factors: chelated zinc with three levels (0, 5, 10) kg H^{-1} and symbolized by (Zn_0, Zn_1, Zn_2) and the second factor, vermicompost with three levels (0, 10, 20)ton H^{-1} and symbolized by (F_0, F_1, F_2). Soil samples were randomly taken before planting from a depth of 0-30 cm, dried, ground and sifted with a sieve with 2 mm holes to estimate the chemical and physical properties of the soil. Table (1) shows the results of the analysis. The field was divided into three replications, and in each replicate there were 9 experimental units. The area of the experimental unit was $6m^2$, its dimensions were 2×3 m. Chelated zinc and vermicompost were added and mixed with the soil well. Maize seeds were sown in a hollow, and the field was irrigated after planting, according to the plant's need. The operations of servicing and removing weeds were carried out as needed, and the plant was thinned to one plant in each pot. The plant was harvested at the stage of full maturity, according to the concentration of nitrogen, phosphorus, potassium and zinc available in the soil after planting. Statistical analysis of the data was conducted using the least difference. LSD was significant at a probability level of 0.05.

Table 1: Some chemical and physical properties of field soil before planting

Values	Unit	Property
7.25	--	Ph
4.63	DS.M^2	Ec_e electrical conductivity
19.51	C mole Ckg^{-1}soil	The exchange capacity of positive ions CEC
0.08	g.kg^{-1}	organic matter
Concentration of ready-made nutrients		
31.25	Mg.kg^{-1}soil	Nitrogen
15.18		Phosphorous
185.18		Potassium
		Zinc
Soil articulations		
175	g.kg^{-1}soil	Sand
325		Silt
500		Clay
Clay loam		Texture
1.35	Mg.g^{-1}	bulk density

Results and discussion

1- The effect of chelated zinc and vermicompost and the interaction between them on the soil content of N, P, K, Zn available in the soil after harvest (mg kg^{-1} soil)

1-1 Nitrogen

The results of the statistical analysis, table2, showed that the effect of adding chelated zinc and vermicompost and their interactions had a significant effect on increasing the available nitrogen in the soil after harvest. The treatment of adding chelated zinc, Zn_2 , gave the highest value of available nitrogen in the soil after harvest, amounting to 46.78 mg N kg^{-1} soil, compared to the two treatments Zn_1 and Zn_0 , which had values of 43.31 and 32.14 mg N kg^{-1} soil, with an increase rate of 8.01 and 31.29% for each. Respectively, as it is noted from the table that the effect of adding vermicompost, also had a significant effect on increasing the available nitrogen in the soil after harvesting, mg N kg^{-1} soil, and that the highest value was in treatment F_2 , which amounted to 46.96 mg N kg^{-1} soil. Compared to the treatments F_1 and F_0 , whose value amounted to 40.18 and 35.20 mg N kg^{-1} soil, with an increase of 16.87 and 25.04% for each of them, respectively. It is also noted from the same table that the interaction effect of adding chelated zinc and the levels of vermicompost all had a significant effect on increasing the available nitrogen in the soil after harvesting, mg N kg^{-1} soil, and that its highest value was in the treatment of the binary interaction of adding chelated zinc with vermicompost, which was represented by the treatment Zn_2F_2, whose value amounted to 56.17 mg N kg^{-1} soil, which did not create a significant difference from the binary interaction treatment of Zn_1F_2, which amounted to

ISSN 2072-3857

50.30 mg N kg^{-1} soil, while the lowest value of available nitrogen in the soil after harvest was when the binary interaction treatment (comparison) and It is the absence of adding chelated zinc and vermicompost, represented by the treatment Zn_0F_0, whose value amounted to 30.33 mg N kg^{-1} soil, with an increase of 85.20%.

Table (2) Effect of chelated zinc and vermicompost and the interaction between them on the available nitrogen in the soil (mg N kg^{-1})

average	Add vermicompost F			addition Chelated zinc Zn
	F_2	**F_1**	**F_0**	
32.14	34.41	32.00	30.33	**Zn_0**
43.31	50.30	42.92	36.71	**Zn_1**
46.78	56.17	45.62	38.55	**Zn_2**
	46.96	40.18	35.20	**Average**
overlap	Vermocompost		Chelated zinc	**L.S.D(0.05)**
7.31	2.60		2.60	

1-2 phosphorous

It is noted through the statistical analysis table (Table 3) that all indicators of the study had a significant effect on the increase in the availability of phosphorus in the soil after harvesting, since the addition of chelated zinc led to an increase in the availability of phosphorus, and that its highest value was in the Z_2 treatment, which amounted to 29.5 mg P kg^{-1} soil, compared to the two treatments Zn_1 and Zn_0 , whose values were 25.10 and 15.91 mg P kg^{-1} soil, with an increase of 17.52 and 46.06% for each of them, respectively. The addition of vermicompost had a significant effect on the increase of available phosphorus in the soil after harvest, and its highest value was in treatment F_2, which amounted to 28.42 mg P kg^{-1} soil, compared to the lowest values represented by the two treatments F_1 and F_0, which amounted to 24.52 and 17.56 mg P. kg^{-1} soil, with an increase rate of 15.53 and 38.21% for each of them, respectively, and it is noted from the same table that the overlapping effect of adding chelated zinc and vermocompost had a significant effect on the increase of available phosphorus in the soil after harvesting, mg P in kg^{-1} soil And that the highest values have a value when the binary interaction of chelated zinc and vermicompost, represented by the treatment Zn_2F_2, which amounted to 35.92 mg kg^{-1} soil, and this value did not create significant for the treatment of the binary interaction Zn_1F_2, which amounted to 31.35 mg kg^{-1} soil The lowest value was when the binary interaction treatment of the comparison treatment Zn0F0, which amounted to 14.20 mg P gm^{-1} soil.

ISSN 2072-3857

Table (3) The effect of chelated zinc and vermicompost and the interaction between them on the available phosphorus in the soil (mg P kg-1)

average	Add vermicompost F			Addition Chelated zinc Zn
	F_2	F_1	F_0	
15.91	18.00	15.53	14.20	Zn_0
25.10	31.35	25.62	18.33	Zn_1
29.50	35.92	32.42	20.15	Zn_2
	28.42	24.52	17.56	**Average**
Overlap	**Vermicompost**		**Chelated zinc**	**L.S.D(0.05)**
4.11	2.43		2.43	

1-3 potassium

The results of the statistical analysis, Table 4, indicated that all indicators of the study represented by the addition of chelated zinc and levels of vermicompost and their interactions had a significant effect on increasing the available potassium in the soil after harvesting, mg K kg^{-1} soil, as the effect of adding chelated zinc was significant in increasing the available potassium in the soil After harvesting mg K kg^{-1} soil, And the highest value was in the Zn2 treatment, which amounted to 219.95 mg K kg^{-1} soil, compared to the lowest values after it, represented by the two treatments Zn_1 and Zn_0, whose values amounted to 208.63 and 187.08 mg K kg^{-1} soil, with an increase of 5.42 and 14.94% for each. Sequentially, the addition of vermicompost also had a significant effect on increasing the available potassium in the soil after harvest, and its highest value was in the F_2 treatment, which amounted to 222.48 mg P kg^{-1} soil, compared to the F_1 and F_0 treatments, whose values were 202.76 and 190.23. mg K kg^{-1} soil, with an increase of 9.72 and 14.49% for each, respectively. It is also noted from the same table that the overlapping effect of adding chelated zinc with vermocompost had a significant effect on increasing the available potassium in the soil after harvesting, mg K kg^{-1} soil, and that its highest value was when the treatment of the two-way interaction of adding chelated zinc fertilizer with vermicompost represented by the treatment Zn_2F_2, whose value amounted to 245.82 mg K kg^{-1} soil, which did not differ significantly from the treatment of the binary interaction of adding chelated zinc with vermicompost, represented by the treatment Zn_1F_2, whose value amounted to 230.39 mg K kg^{-1}, while the lowest value was for potassium availability in the soil after harvest, which was represented by the treatment Zn_0F_0, which amounted to 180.30 mg K kg^{-1}.

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Table (4) Effect of chelated zinc and vermicompost and the interaction between them on available potassium in the soil after harvesting (mg K kg-1 soil)

Average	Add vermocompost F			Addition Chelated zinc Zn
	F_2	F_1	F_0	
187.08	197.25	189.17	180.30	Zn_0
208.63	230.39	203.50	192.00	Zn_1
219.95	245.82	215.62	198.41	Zn_2
	222.48	202.76	190.23	المـــــــــتوسط
Overlap	**Vermocompost**		Chelated zinc	**L.S.D(0.05)**
17.25	6.16		6.16	

1-4 zinc

It is noted through the results of the statistical analysis table (Table 5) that all the indicators of the study had a significant effect on increasing the ready-made compaction in the soil after harvesting. Kg^{-1} soil, compared to the two treatments Zn_1 and Zn_0, whose values were 6.38 and 3.77 mg kg^{-1} soil, with an increase of 12.53 and 47.49% for each of them, respectively The addition of vermicompost had a significant effect on increasing the readiness of zinc in the soil after harvest, and its highest value was in treatment F_2, which amounted to 6.49 mg kg^{-1} soil, compared to the treatments of adding vermicompost F_1 and F_0, which amounted to 5.92 and 4.92 mg kg^{-1} Soil, with an increase rate of 9.62 and 24.19% for each of them, respectively. It is also noted from the same table that the effect of the binary interaction of adding chelated zinc as a fertilizer and with vermicompost had a significant effect on increasing the readiness of zinc in the soil after harvest, and that the highest value was when the treatment of the binary interaction of adding chelated fertilizer zinc with vermicompost to the treatment Zn_2F_2, which had a value of 8.15 mg kg^{-1} soil, and the treatment of the two-interference of zinc chelated vermocompost for the treatment Zn_1F_2 gave a high value of 7.10 mg Zn kg^{-1} soil, while the lowest value was for the readiness of zinc in the soil, which was represented by the comparison treatment Zn_0F_0, which amounted to 3.35 mg Zn kg^{-1} soil.

ISSN 2072-3857

Table (5) Effect of chelated zinc and vermicompost and the interaction between them on available zinc in soil after harvest (mg Zn kg^{-1} soil)

Average	Add Vermocompost F			addition Chelated zinc Zn
	F_2	F_1	F_0	
3.77	4.22	3.75	3.35	**Zn_0**
6.38	7.10	6.63	5.42	**Zn_1**
7.18	8.15	7.40	6.00	**Zn_2**
	6.49	5.92	4.92	**average**
Overlap	**Vermocompost**		**Chelated zinc**	**L.S.D(0.05)**
1.16	0.32		0.32	

It is noted from the results of Tables 2, 3, 4 and 5 that for all study indicators represented by the addition of chelated zinc and vermocompost and their interactions, it led to a significant increase in the concentrations of nutrients in the soil after harvest (mg kg^{-1} soil) And the reason for the increase in the content of these elements may be attributed to the fact that chelated zinc has a role in the work of enzymes inside the plant and the activation of the work of plant growth regulators, and thus an increase in the vegetative and root system(6). The addition of chelated zinc works to chelate the nutrients and increase their readiness in the soil after harvest, as it worked on liberating the ready form in the soil, which led to an increase in the readiness of these nutrients in the soil (7). As the chelated zinc contributes to accelerating plant cell division, as well as the ability to improve the physical, chemical and fertility properties of the soil, and thus increase the available nitrogen, phosphorus, potassium and zinc in the soil after harvest (8). The addition of chelated zinc works to increase the root and vegetative total, as it led to an increase in root secretions of organic acids resulting from the addition of chelated zinc added ground to the soil. In the soil, including nitrogen, phosphorus, potassium, as well as zinc after harvest. The addition of vermicompost vermicompost works as an organic material that leads to an increase in the soil content of the nutrients above, in addition to increasing the content of vermicompost on these elements, as well as it contains elements of appropriate quantities and according to the organic matter, which is liberated upon release. The reason may also be attributed to the increase in the readiness of major and minor nutrients, as zinc in the soil led to the liberation of these elements, and thus increased their readiness in the soil and became more accessible for absorption by the plant. As the addition of chelated zinc with ferrocompost works to stimulate the work of the roots to secrete organic acids, and these acids work to reduce the pH of the soil and thus weathering minerals and

ISSN 2072-3857

increasing their readiness in the soil (9). Also, the significant effect of increasing the readiness of these nutrients leads to a direct effect on the soil of the major and minor nutrients such as zinc when decomposed, as it works to release hydrogen ions and thus lowers the pH of the soil as well as the formation of organic acids, which also lead to the formation of humus complexes, which prevent sedimentation Some elements, such as phosphorus, act on its chelation and prevent it from poverty and make it in the form of a humus complex, which leads to an increase in its readiness in the soil after harvest (10). Also, the content of vermicompost of nutrients had a significant effect on increasing the readiness of nutrients in the soil after harvest, as it has a high content of total nitrogen and release of the ready form in the harvest soil, which differs compared to the comparison treatment. These results are consistent with what was found (11), Vermocompost also prevents the precipitation of phosphorus in the form of calcium phosphate, as well as the formation of phosphohumic complexes in the soil solution that prevent it from precipitating (12) and (13). The effective role resulting from the bilateral interaction of adding chelated zinc with vermocompost led to a reduction in sedimentation and adsorption processes on the surfaces of colloids. 14) These results are consistent with the findings of (15) and the findings of (11) who found an increase in the concentrations of nutrients, including nitrogen, phosphorus and potassium, in the soil after harvest as a result of adding chelated zinc with vermicompost, the cause of which is attributed to the role of these acids. In the liberation of micro and macro nutrients from some minerals, in order to replace the potassium ion resulting from the dissolution of organic acids (16).

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