Effect of adding chelated zinc and vermicompost and their interaction on crop characteristics and components in zea mays L.

Fatima Bassem Yassin
Fatema.Basim.Yassien@uomus.edu.iq

Zainab Nadhum Aziz
Zainab.Nadhum.Aziz@uomus.edu.iq

Al_Mustaqbal University, Babylon, Iraq

Abstract

In the fall of 2022, a field experiment was carried out on the yellow corn crop in the College of Agriculture site between longitudes "44023'46.00 north and latitudes 32022'51.892" east to study effect of adding chelated zinc and vermicompost and their interaction on zea mays L. characteristics and components in zea mays L. within a randomized complete block design (RCBD) with three replicates. And with two factors:- The first factor: control treatment (without fertilization) and fertilization at a level of (5 kg hectar-1) , fertilization at a level of (10 kg hectar-1). The second factor: Adding vermicompost fertilizer mixed with the soil before planting at three levels: control treatment (without fertilization), fertilization at a rate of (10 tons hectar-1), fertilization at a rate of (20 tons hectar-1(

With values of 5.69 tonsH-1, 12.43 tonsH_1, and 501.72 g, the dual interaction treatment Zn2F2 performed better by providing the highest grain yield, biological yield. It also increased the availability of zinc and the major nutrients nitrogen, phosphorus, and potassium in the soil.

Keywords: Zinc , vermicompost , earthworms , zea mays L.

Introduction

For plants, zinc is a necessary element that is vital to numerous physiological functions. The amino acid tryptophan, a crucial part of indole acetic acid (IAA), which is crucial for cell and stem elongation, is formed with zinc's help. Zinc also affects plant metabolic activities by helping to stabilize ribosome components and build cytochrome. Plants that are zinc deficient have severe crop degeneration, which impacts plant growth and development. Zinc is therefore a necessary element for plants. 7. Over the course of six millennia, earthworms have been instrumental in the creation of soil and in boosting its fertility, making them one of the most significant invertebrates in the soil. Because of their influence on the environment, earthworms are distinguished by their capacity to live and procreate in wetlands as well as by the wide variety of species they have. Genetic mutations are thought to be the cause of earthworm species' variety. The ability to thrive in a particular environment, with ideal temperatures between 15 and 25 °C and pH levels between 4.4 and 6.5, is what distinguishes earthworms. Another characteristic of earthworms is their capacity to keep soil moisture levels between 20 and 80%. (5)(12). Due to its widespread usage in maize and other crop production to produce high-quality, long-lasting crops, vermicompost is currently distinguished by its capacity to increase agricultural yield. (11) Maize (Zea mays L.), a member of the Poaceae family, is one of the most important cereal crops worldwide due to its wide range of uses and significant economic value. It serves as a staple food, animal fodder, and raw material in various industries (3.(

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-1Effect of Chelated Zinc Fertilizer Application on Yield Components and Characteristics
-2Effect of Vermicompost Fertilizer Application on Yield Components and Characteristics
-3Effect of the Interaction Between Chelated Zinc and Vermicompost
Fertilizers on Yield Components and Characteristics

Materials and methods

In order to determine the impact of vermicompost and chelated zinc, as well as their interactions, on the properties of the crop and its constituents in clay soil, a field experiment was conducted on the yellow corn crop in the College of Agriculture field at the University of Babylon site during the fall of 2022 between longitudes "44023'46.00 north and latitudes 32022'51.892 . within a randomized complete block design (RCBD) with three replicates .Two elements were added as part of the experiment. Adding chelated zinc at three different levels (10.5, 0) kg H_1 was the first factor; adding vermicompost at three different levels (20, 10, 0) tons H_1 was the second. The symbols for chelated zinc and vermicompost are Zn2, Zn1, Zn0, and F2, F1, F0, respectively. To determine the soil's physical and chemical characteristics, soil samples were then randomly selected prior to planting, air-dried, pulverized, and sieved using a sieve with a 2 mm hole diameter. The field was separated into three duplicates, each of which included nine experimental units, each measuring six square meters. Prior to planting, vermicompost and chelated zinc were applied and combined with the soil. The field was irrigated as needed after the yellow corn seeds were planted. When the plant reached full maturity, it was harvested after being trimmed to just one plant. The least significant difference was used in the statistical analysis of the plant at the 0.05 probability level.

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

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Results and discussion

The impact of adding vermicompost and chelated zinc, as well as how they interact, on the traits of the crop and its constituent parts

-1Weight of 1000 grains (g (

The weight of a thousand grains (g) was significantly impacted by each of the study parameters, according to the statistical analysis results in Table (4). In comparison to the Zn1 and Zn2 treatments, whose values reached 340.14 and 249.11 g, respectively, with an increase rate of 60.23% and 37.59%, it is observed that the addition of chelated zinc significantly affected the thousand grains characteristic, with the Zn2 treatment having the highest value at 399.16 g. The same table also shows that the addition of vermicompost significantly impacted the thousand-grain trait, with treatment F2 having the highest value at 486.88 g, compared to treatments F1 and F0, which had the highest values at 328.70 and 263.84 g, respectively, with an increase rate of 50.04% and 33.35%. The table also shows that the thousand-grain trait was significantly impacted by the interaction between chelated zinc and vermicompost, with treatment Zn2F2 having the highest value at 501.72 g, compared to the comparison treatment's 245.16 g, representing a 104.65% increase.

Table 1 Effect of chelated zinc, vermicompost and their interaction on 1000 grain weight (g.(

Average	**Add vermicompost F**			**Addition Chelated zinc Zn**
	F_2	**F_1**	**F_0**	
249.11	252.00	250.18	245.16	**Zn_0**
340.14	433.92	333.31	253.20	**Zn_1**
399.16	501.70	402.61	293.17	**Zn_2**
	395.87	328.70	263.84	**Average**
Overlap	vermicompost		Chelated zinc	**L.S.D(0.05)**
17.45	9.25		9.25	

-2Grain yield (tonsH_1 (

All study indicators significantly increased the yield of yellow corn grains (tonsH_1), according to the statistical analysis results in Table (1). In comparison to the Zn1 and Zn0 treatments, which each had a value of 4.49 and 3.73 tons H_1 with an increase rate of 29.41% and 22.72%, respectively, the Zn2 treatment had the highest value, 4.83 tons h-1, indicating that the addition of chelated zinc significantly increased the grain yield. The same table also shows that the addition of vermicompost

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significantly increased grain yield, with the F2 treatment having the highest value at 4.87 tonsH_1, compared to the F1 and F0 treatments at 4.35 and 3.81 tonsH_1, respectively, with an increase rate of 27.74% and 21.15%. in order. The table also shows that the combination of vermicompost and chelated zinc significantly increased grain yield, with the highest value occurring in the Zn2F2 treatment (amounting to 5.69 tons H_1), compared to the comparison treatment Zn0F0 (amounting to 3.65 tons H_1), with an increase rate of 55.89%

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Table 2 Effect of chelated zinc, vermicompost and their interaction on the yield of yellow corn grains (tonH_1(

Average	**Add vermicompost F**			**Addition Chelated zinc Zn**
	F_2	F_1	F_0	
3.74	3.79	3.77	3.65	**Zn_0**
4.49	5.15	4.53	3.80	**Zn_1**
4.84	5.69	4.82	4.00	**Zn_2**
	4.88	4.37	3.82	**Average**
Overlap	Vermocompost		Chelated zinc	**L.S.D(0.05)**
1.70	0.27		0.27	

-3Biological yield (tonH_1(

All study factors significantly increased the biological output of yellow corn, tons h-1, according to the statistical analysis results in Table (2). The biological yield was found to increase significantly with the addition of chelated zinc. The Zn2 treatment had the highest value, reaching 11.21 tons h-1, while the Zn1 and Zn0 treatments reached 10.54 and 9.34 tons h-1, respectively, with an increase rate of 20% and 16.66%. The same table also shows that adding vermicompost significantly increased the biological yield, with treatment F2 having the highest value at 11.18 tons per hour, compared to treatments F1 and F0, which had the highest values at 10.36 and 9.55 tons per hour, respectively, with increase rates of 17.17% and 14.65%. The table also shows that the combination of vermicompost and chelated zinc significantly increased the biological yield, with treatment Zn2F2 having the highest value at 12.43 tons per hour, compared to comparison treatment Zn0F0, which had a value of 9.10 tons per hour, representing a 36.59% increase.

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Table 3 Effect of chelated zinc, vermicompost and their interaction on the biological yield (tonH_1.(

Average	Add vermicompost			Addition Chelated zinc Zn
	F_2	F_1	F_0	
9.35	9.52	9.43	9.10	Zn_0
10.54	11.62	10.45	9.55	Zn_1
11.22	12.43	11.22	10.00	Zn_2
	11.19	10.37	9.55	**Average**
Overlap	Vermocompost		Chelated zinc	**L.S.D(0.05)**
2.80	0.31		0.31	

-4Harvest index %

While the addition of chelated zinc had a significant effect on the harvest index trait, the highest value was in the Zn2 treatment, reaching 4.90%, compared to the Zn1 and Zn0 treatments, which each reached 42.48 and 39.93%, with an increase rate of 7.35 and 6.85%, respectively. The statistical analysis results in Table (3) demonstrated that all study indicators had a significant effect on the harvest index trait. The same table also shows that the harvest index trait was significantly impacted by the addition of vermicompost, with the F2 treatment having the highest value at 43.3%, compared to the F1 and F0 treatments, which had the highest values at 41.76 and 39.96%, respectively, with an increase rate of 8.52 and 7.85%. The table also shows that the harvest index trait was significantly impacted by the interaction between chelated zinc and vermicompost, with the Zn2F2 treatment having the highest value at 45.77%, up 14.13% from the comparison treatment, which reached 40.10% .

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Table 4 Effect of chelated zinc, vermicompost and their interaction on harvest index%

Average	Add vermicompost F			Addition Chelated zinc Zn
	F_2	F_1	F_0	
39.96	39.81	39.97	40.10	Zn_0
42.48	44.32	43.34	39.79	Zn_1
42.90	45.77	42.95	40	Zn_2
	45.77	41.76	39.96	Average
Overlap	Vermocompost		Chelated zinc	L.S.D(0.05)
2.43	1.35		1.35	

Discussion

The results presented in Tables 1 to 4 clearly indicate that the application of chelated zinc, vermicompost, and their interaction had a significant positive impact on the growth and yield characteristics of yellow corn. The observed enhancement can be attributed to the role of trace elements—particularly zinc—in promoting physiological processes such as the expansion of leaf area, increased respiration, and improved carbon metabolism. These physiological changes enhance the plant's efficiency in water and nutrient uptake through the root system, which is reflected in improved grain filling, increased grain weight, and enhanced protein metabolism—all contributing to improved yield components (14). These findings are consistent with previous studies (1, 4.(

Zinc also plays a critical role in improving the efficiency of internal photosynthetic processes by facilitating the transport of assimilates from source organs (leaves) to sink organs (grains), thereby increasing grain yield. This observation aligns with results reported by studies (10, 13, 2, 9). Moreover, zinc is involved in the synthesis of essential plant compounds, including hormones and enzymes, which are vital for growth and development. For instance, one study documented a 43% increase in the biological yield of yellow corn following the application of 24 kg Zn ha^{-1}, while another (11) observed a 68% increase in total plant biomass compared to the control.

The data also reveal that vermicompost significantly enhances crop performance. Its content of growth hormones and regulatory substances contributes to stimulating cell division, activating essential physiological functions, and increasing endogenous plant secretions, ultimately leading to higher dry matter accumulation and increased leaf number. Vermicompost is also rich in

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nutrients that become more bioavailable upon decomposition, promoting photosynthesis, elevating glucose concentration, and enhancing dry matter content in vegetative tissues (8.(

In addition to its role in improving nutrient availability within the soil solution, vermicompost facilitates the development of a robust root system, which in turn improves nutrient uptake and supports vigorous vegetative growth (6). The decomposition of vermicompost also releases organic acids and natural chelating agents that reduce nutrient fixation and enhance their mobility in the rhizosphere, making them more accessible to plant roots (15). This results in improved nutrient acquisition, which is essential for optimal plant development.

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