Effect of fertilization with vermicompost and mycorrhizal fungi on the growth and yield of pepper plant

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Abstract

A potting experiment was conducted during the autumn agricultural season 2023-2024 in Diyala Governorate and under protected cultivation conditions, and the study included two factors: the first is the addition of earthworm fertilizer (Vermicompost)) and three levels 0, 5 and 10 tons ha-1, and the second factor is the addition of mycorrhiza fungus to the soil and at three levels are without addition and a week before planting and during the planting date by adding 10 g 15 kg-1, In order to study the effect of adding vermicompost fertilizer and mycorrhiza fungus on the growth and yield of pepper plant and some soil characteristics. The experiment included 9 coefficients resulting from combinations between the aforementioned study factors. A factor experiment was applied according to CRD design and three repeats and the statistical analysis was using the (SAS) program and the averages were compared using the Dunkin' polynomial test and under the probability level of 5%. The results showed that the effect of adding vermicompost fertilizer by 10 tons per ha-1 and mycorrhiza fungus with agriculture was significantly superior in the average plant height, number of leaves, leaf area, wet weight of the vegetative total, plant yield and number of leaves, leaf area, wet weight of the vegetative total, plant yield, number of fruits per plant, fruit weight, fruit size and total yield, as well as significant differences when the factors under study overlap.

Keywords: vermicompost, mycorrhiza fungus, pepper.

Introduction

The intensive use of fertilizers and chemical pesticides in the agricultural field has led to an impact on soil fertility worldwide and beneficial microorganisms and made crops more vulnerable to diseases in addition to its impact on human health and the environment, and to overcome these problems, we must use environmentally friendly alternatives, including vermicompost or the so-called worm fertilizer [19]. Vermicompost is defined as organic fertilizer resulting from a group of biological reactions that lead to the transformation of organic matter into humus-like substance due to the activity of earthworms. The nutritional properties of worm fertilizer are better than traditional organic fertilizer, as this fertilizer is a source of many macro and micronutrients and thus improves the growth and productivity of crops.

The mycorrhiza fungus is one of the most abundant organisms in the soil, as it is symbiotically associated with most plants and is found in most vegetation systems, whether in the subarctic regions or tropical rainforests and even in aquatic ecosystems, as it coexists with the roots of most plants (more than 90% of plant hosts), as plants provide fungi with carbohydrates and in return, the fungus provides the plant with nutrients through the roots of the plant through its fungal filaments (Hyphae) that supply it in Soil to absorb

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nutrients far from the root system and make them available for absorption by the roots, especially the element phosphorus, as it acts as root hairs and thus acts as an adjunct to the root system [6,14.[

The pepper plant (Capsicum annuum L.) belongs to the Solanaceae family and is grown in different types of soils and is an important vegetable because it contains large amounts of vitamins and multiple phenols as well as many essential oils and is used fresh or cooked and maintains health as well as prevents heart disease and blood
clots [16]. Pepper fruits contain 4.8% carbohydrates and 1.2% proteins, in addition to containing potassium, calcium and fluoride that prevent tooth decay and contain vitamins A, C and E [4.[

cultivated areas of green pepper in Iraq amounted to 21,600 dunams, with an average productivity of the cultivated area of 2,724.8 (kg dunam-1) and for the productive area of 2,725.8 (kg dunums-1), and the total production reached 58,800 tons.

This study aims to:

•Study the effect of vermicompost fertilizer on the growth and yield of pepper.

•Study the effect of mycorrhiza fungus in increasing the readiness of nutrients in the growth and yield of pepper.

Materials and methods

A potted experiment was carried out in the autumn agricultural season 2023-2024 for the purpose of studying the effect of adding vermicompost fertilizer and mycorrhiza fungus on the growth and yield of pepper plants and some soil traits and under protected cultivation conditions, where random samples were taken from potted soil that was brought from one of the nurseries of the city of Baqubah (apple nursery) and by 10 samples for the purpose of analysis. Soil samples were analyzed in the laboratory and Table 1 illustrates some of the chemical and physical characteristics of the study soil before planting.

A factor experiment was carried out according to the complete randomized design (CRD), as the experiment included the study of two factors: the first is the addition of earthworm fertilizer (Vermi Compost) at three levels 0, 5 and 10 tons ha-1 and its symbol V1, V2 and V3 sequentially, and the second factor is the addition of mycorrhiza fungus to the soil and at three levels: without addition, a week before planting and during the planting date, by adding 10 g and its code M1, M2 and M3 sequentially. As for the distribution of transactions, it was random within the containers, which had a capacity of 15 kg per pot, and with three repeats, the total became 3 * 3 * 3 = 27 experimental units.

The results were analyzed using statistical software SPSS version 26 (Morgan et al., 2019). Significant differences between the averages were tested on the Duncan polynomial test at a probability level of 0.05 [15.[

Prepare 27 perforated pots from the bottom with a height of 40 cm, a diameter of 40 cm from the top and a base diameter of 20 cm, and fine gravel was placed under each pot, then filled with 15 kg of soil with a height of 20 cm and then added vermicompost fertilizer and mycorrhiza fungus to the pots according to the above treatments .

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Table 1. shows some chemical and physical properties of the soil of the study before planting

properties		Value	Unit
EC Conductivity (1:1)		0.8	Desi Samnazm^{-1}
pH (1:1)		7.5	
Organic matter		1.3	g kg-1
Carbonate minerals		75	g kg-1
Gypsum		5.4	
Positive ion exchange capacity CEC		5	Centi Mole Shipment Kg^{-1} Soil
Bulk density		15	Mica Gram. 1 kg^{-1}
	Calcium Ca+	11.5	
	Magnesium Mg+	5	
	Sodium Na+	6.5	
Soluble ions	Potassium K+	2	Millimol L^{-1}
	Chloride Cl^{-1}	9.5	
	Sulfate SO_4^{-1}	6.3	
	Bicarbonate HCo_3^{-1}	7	
	Carbonate CO_3^{-2}	Nill	
Elements	Nitrogen	4	
available	Phosphorus	3.5	mg kg^{-1} soil
	Potassium	24	
	Clay	10.64	%
Loamy Sand	Alluvial	0.96	
	Sand	88.4	

Earthworm fertilizer was obtained locally from the aforementioned nursery, whose characteristics are shown according to the manufacturer's content in Table (2) The Mycorrhiza vaccine type Glomus sp was obtained after the end of the master's study for one of the students in the Department of Soil Science and Water Resources in the form of (soil + infected roots) with a density of 70% and the type of infection by vesicles.

Table 2. shows some of the chemical qualities of earthworm fertilizer

properties	concentration	unit
O.C	22.50	%
N	1.75	%
P	1.00	%
K	0.75	%
Ca	0.60	%
Mg	0.45	%
S	300.00	mg kg^{-1}
Fe	8.00	mg kg^{-1}
Cu	5.75	mg kg^{-1}
Zn	8.60	mg kg^{-1}

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Table 3. Names and symbols used experimentally

Treatment symbols	Treatment type
V1M1	(without adding Vermicompost + without adding Mycoraiza)
V1M2	(without adding vermicompost + adding 10 g of mycoraiza a week before planting)
V1M3	(without adding vermicompost + adding 10 g mycorraza during planting time)
V2M1	(Add Mycoraeza + 25 g Vermicompost)
V2M2	(Add 10 g of Mycoraiza a week before planting + 25 g Vermicompost)
V2M3	(Add 10 g of Mycorraza during planting time + 25 g Vermokompost)
V3M1	(without added Mycoraeza + 50 g Vermokompost)
V3M2	(Add 10 g of Mycoraiza a week before planting + 50 g Vermokompost)
V3M3	(Add 10 g of Mycoraeza during planting time + 50 g Vermokompost)

The pots were prepared for planting on 9/26/2023, and the pepper seeds of the California wonder variety, produced by the American company Agri seeds, were planted on 2/10/2023, with 10 seeds per anvil, and the date of emergence was recorded on 10/10/2023, and after germination, the process of thinning was performed for the plants. And I left 3 plants in one pot.

The irrigation process was carried out using a drip irrigation system, which consists of the main pipe, which is a source of irrigation water processing, and a pump with a horsepower of 6.5 horsepower, Qatar the main pipe is 1.5 inches distributed over the width of the greenhouse 9 m, from which the sub-drip pipes distributed on the pots were extended, and the number of irrigations was 30 irrigations.

Studied qualities

Vegetative growth qualities

-1Plant height (cm(

The height of the plant from soil level to the growing peak of the plant is measured by means of a tape measure at the end of the experiment.

-2Number of leaves (leaf-1(

By the number of total leaves of the plant at the end of the season.

-3Total paper area (cm2(

The leaf area (the third fully matured leaf) of each plant was calculated according to the gravimetric method described by [17] as follows:

-1The sheets are pierced by a Crook Borer drill.

-2Sensitive electronic scale.

-3Preparing plants to calculate the leaf area, as the leaf petioles are separated so that they do not enter into the calculation of the area and keep the leaves fully grown.

-4Stack the full-sized leaves one on top of the other in order to be pierced with a drill and take the discs from between the veins of the leaves.

-5The tablets are weighed on the scale immediately and the weight is taken.

-6The blades of the papers are weighed with the discs and take their wet weight.

-7Calculate the area of the circle of the disks from the mathematical equation: r2 x 3.14 x the number of disks

-8The total paper area of the papers is calculated from the following equation:

ISSN 2072-3857

Total leaf area = (total blade weight / disc weight) X circle area of discs X number of leaves in the plant.

-4Wet weight of vegetative total (g(

The wet weight of the vegetative total was measured by the sensitive balance with two ranks after the sorter.

-5Dry weight of the vegetative total (g(

The same plants that took their wet weight were weighed and then placed in perforated paper envelopes, then air-dried and then placed in an oven with a temperature of 70 °C 0 until the weight was proven and then the rate was taken.

Yield qualities

-3Fruit weight (g(

The weight of one fruit was calculated by taking the average weight of the fruits per experimental unit.

-4Fruit size

The size of the fruits was measured by the volume of water displaced and by taking the average size of the fruits per experimental unit.

-2Number of fruits in the plant

The number of fruits per plant was calculated and for the end of the experiment.

-1Yield of one plant (g plant-1(

The yield of one plant was calculated by the sum of the fruit weights for the end of the experiment.

-5Total yield (kg(

The total yield of fruits was calculated in the experimental unit until the end of the experiment

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Results and discussion

-1Plant height

The results of Table 4 showed the effect of adding vermicompost fertilizer and mycorrhiza fungus on plant height. The coefficients of adding the vermocompost at the level V2 and V3 significantly outperformed the comparison coefficient (V1) by an increase of 25.29 and 28.40%, respectively, but the coefficients of V2 and V3 did not differ from each other significantly. The results of the table referred to below showed that the treatment of adding mycorrhiza fungus during cultivation (M3) significantly outperformed other treatments, as the percentage of increase in plant height was 28.99% when treating (M3) compared to the treatment of not adding Mycorrhiza fungus (M1). The results of the interference showed that all interference coefficients were superior to the comparative coefficient, except for the interference coefficient (V1M2) from which they did not differ significantly. The overlap treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment as it gave the highest height of the plant reached 43 cm. It did not differ morally with the treatment of (V2M3.(

ISSN 2072-3857

Table 4. Effect of adding vermicompost fertilizer and mycorrhiza fungus on plant height (cm(

Treatment	V1	V2	V3	Means
M1	24.33 e	33.67 bcd	31.67 cd	29.89 b
M2	28.00 ed	34.33 bcd	35.33 bc	32.56 b
M3	33.33 bcd	39.33 ab	43.00 a	38.56 a
Means	28.56 b	35.78 a	36.67 a	

-2The total leaf area of the plant

The results of Table 5 showed the effect of adding vermicompost fertilizer and mycorrhiza fungus on plant height. The Vermocompost Level 3 (V3) addition treatment significantly outperformed the comparison (V1) and the addition (V2) treatment with an increase of 80.44 and 33.97% respectively. The results of the same table showed a significant superiority of the treatment of adding mycorrhiza during cultivation (M3) significantly over other coefficients, as the percentage of increase in plant height was 99.12% compared to the treatment of not adding mycorrhiza fungus (M1) and the results of the overlap between the addition of vermukompost fertilizer and mycorrhiza fungus showed that all interference coefficients exceeded the comparison treatment except for the interference treatment V2M1 and V1M2, which did not differ significantly from the comparison treatment, but the overlap treatment between the addition of the third level of vermicompost fertilizer with the addition of fungus during cultivation (V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment, as the paper area reached 1061.1 cm2, while the paper area decreased by comparison treatment 289.5 cm2.

Table 5. Effect of adding vermicompost fertilizer and mycorrhiza fungus on the total leaf area of the plant (cm2(

Treatment	V1	V2	V3	Means
M1	289.5 f	464.8 def	485.1 e	413.1 c
M2	405.1 ef	573.5 de	806.9 b	595.2 b
M3	609.6 cd	784.6 bc	1061.1 a	822.7 a
Means	434.7 c	585.5 b	784.4 a	

-3Number of leaves

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The results of Table 6 on the effect of adding vermicompost fertilizer and mycorrhiza fungus on the number of leaves in the plant were shown. As the two coefficients of adding the vermocompost level II and III (V2 and V3) significantly outperformed the comparison treatment (V1) by an increase of 25.64 and 30.25%, respectively, but the two addition coefficients (V2 and V3), but they did not differ from each other significantly.

The results of the same table showed that the M3 treatment significantly exceeded the other coefficients, as the percentage of increase in the number of leaves was 52.46% at the treatment of (M3) compared to the treatment of not adding the mycorrhiza fungus (M1.(

The results of the interference showed that all interference coefficients outperformed the comparison coefficient. However, the two overlap coefficients between the addition of the second and third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V2M3 and V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment with an increase of 106.38 and 114.89%, but they did not differ significantly from each other.

Table 6. Effect of Vermicompost and Mycorrhiza fertilizer on leaf count (leaf-1(

Treatment	V1	V2	V3	Means
M1	15.67 d	21.33 c	24.00 bc	20.33 c
M2	22.33 c	28.00 b	27.00 b	25. 78 b
M3	27.00 b	32.33 a	33.67 a	31.00 a
Means	21.67 b	27.22 a	28.22 a	

-4Wet weight of the vegetative total

The results of Table 7 on the effect of the addition of vermocompost and mycorrhiza fungu on the wet weight of the root system are indicated. The Vermocompost Level 3 (V3) addition treatment significantly outperformed the comparison (V1) and the addition (V2) treatment with an increase of 66.01 and 35.07% respectively.

The results of the table below showed that the treatment of adding mycorrhiza during cultivation (M3) significantly outperformed other coefficients, as the percentage of increase in wet weight of the root system was 78.36% compared to the treatment of not adding mycorrhiza fungus (M1.(

The results of the above table showed that all interference coefficients outperformed the comparison coefficient, except for the interference treatment V2M1 and V1M2, which did not differ significantly from the comparison treatment, but the interference treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during

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cultivation (V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment, as it gave the highest increase in the wet weight of the vegetative total amounting to 95.00 g, while the wet weight of the root total in the comparison treatment decreased by 34.67 g.

Table 7. Effect of vermicompost and mycorrhiza fertilizer on wet weight of vegetative total (g(

Treatment	V1	V2	V3	Means
M1	34.667 d	40.667 d	54.000 c	42.111 c
M2	37.667 d	58.333 c	75.667 b	58.222 b
M3	60.000 c	70.333 b	95.000 a	75.111 a
Means	45.111 c	55.444 b	74.889 a	

-5Dry weight of the vegetative total

The results of Table 8 on the effect of the addition of vermocompost and mycorrhiza fungus on the dry weight of the vegetative system were indicated. The second and third level vermocompost addition coefficients (V2 and V3) significantly outperformed the comparison coefficient (V1) by an increase of 91.74 and 8.91%, respectively, but the addition coefficients V2 and V3 did not differ significantly from each other.

The results of the table referred to above confirmed the significant superiority of the treatment of adding mycorrhiza during cultivation (M3) over other coefficients, as the percentage of increase in dry weight of the vegetative total was 57.82% compared to the treatment of not adding mycorrhiza fungus (M1.(

The results of table 8 showed that all interference coefficients were superior to the comparison coefficient, except for the V1M2 interference coefficient, which did not differ significantly with the comparison treatment. However, the interaction treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation gave the highest increase in the dry weight of the vegetative total amounted to 30.33 g, while the dry weight of the vegetative total decreased in the comparison treatment to 9.67 g.

Table 8. Effect of adding vermicompost and mycorrhiza fertilizer on dry weight of vegetative total (g(

Treatment	V1	V2	V3	Means
M1	34.667 d	40.667 d	54.000 c	42.111 c
M2	37.667 d	58.333 c	75.667 b	58.222 b
M3	60.000 c	70.333 b	95.000 a	75.111 a
Means	45.111 c	55.444 b	74.889 a	

ISSN 2072-3857

Yield qualities

-1Fruit weight

The results of Table 9 on the effect of the addition of vermicompost fertilizer and mycorrhiza fungu on the weight of the fruit are indicated. The Vermocompost Level 3 (V3) addition treatment significantly outperformed the comparison (V1) and V2 with an increase of 65.24 and 16.02% respectively.

The results of the table referred to below showed that the treatment of adding mycorrhiza during cultivation (M3) significantly outperformed other treatments, as the percentage of increase in fruit weight reached 83.49% at the treatment of (M3) compared to the treatment of not adding mycorrhiza fungus (M1.(

The results of the overlap between the addition of vermocompost fertilizer and mycorrhiza fungus showed that all interference coefficients exceeded the comparison treatment, but the interaction treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment, as the weight of the fruit was 90.88 g, while the weight of the fruit in the comparison treatment was 32.67 g.

Table 9. Effect of adding vermicompost fertilizer and mycorrhiza fungus on fruit weight (g(

Treatment	V1	V2	V3	Means
M1	32.67 h	41.82 g	45.65 f	40.05 c
M2	41.32 g	60.78 d	72.16 c	58.09 b
M3	52.31 e	77.27 b	90.88 a	73.49 a
Means	42.10 c	59.96 b	69.57 a	

-2Fruit size

The results of Table 10 showed the effect of adding vermicompost fertilizer and mycorrhiza fungus on fruit size. The Vermocompost Level 3 (V3) addition treatment significantly outperformed the comparison (V1) and V2 with an increase of 85.68 and 18.66% respectively.

The results of the table below indicated that the treatment of adding mycorrhiza fungus during cultivation (M3) significantly outperformed other coefficients, as the rate of increase in fruit size was 107.69% compared to the treatment of not adding mycorrhiza fungus (M1.(

The results of the interference between the addition of vermicompost fertilizer and mycorrhiza fungus showed that all interference coefficients outperformed the comparison treatment, except for the interference coefficients V2M1 and V1M2, which did not differ significantly from the comparison treatment, and the interaction treatment between the addition of the third

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level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed the rest of the interference coefficients as well as the comparison treatment, as it gave the largest fruit size of 100.18 cm3, while the size of the fruit in the comparison treatment decreased to 29.67 cm3.

Table 10. Effect of adding vermicompost fertilizer and mycorrhiza fungus in the fruit size (cm3(

Treatment	V1	V2	V3	Means
M1	29.67 e	33.69 e	44.80 d	36.05 c
M2	35.00 e	57.27 c	57.80 c	50.02 b
M3	44.53 d	79.93 b	100.18 a	74.88 a
Means	36.40 c	56.96 b	67.59 a	

-3Number of fruits in the plant

The results of Table 11 on the effect of adding vermicompost fertilizer and mycorrhiza fungus on the number of fruits. The coefficients of adding vermocompost at the third level (V3) and the second level (V2) significantly outperformed the comparison treatment (V1) by giving it the highest number of fruits of 5.60 and 5.09 respectively.

The results of the table referred to above showed that the treatment of adding mycorrhiza during cultivation (M3) significantly exceeded the treatment of not adding mycorrhiza fungus (M1) and did not differ significantly with the treatment of adding mycorrhiza fungus before planting (M2), as the rate of increase in the number of fruits reached 31.06% compared to the treatment of not adding mycorrhiza fungus (M1.(

The results of the interference between the addition of vermocompost fertilizer and mycorrhiza fungus showed that all interference coefficients outperformed the comparison treatment, except for the interference factor (V1M2). The interference treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed the interference coefficients as well as the comparison treatment, except for the interference coefficient (V3M2) as it did not differ with it significantly.

ISSN 2072-3857

Table 11. Effect of adding vermicompost fertilizer and mycorrhiza fungus on the number of fruits

Treatment	V1	V2	V3	Means
M1	3.233 e	4.600 cd	4.500 cd	4.111 b
M2	3.900 de	5.332 bc	5.966 ab	5.066 a
M3	4.500 cd	5.333 bc	6.333 a	5.388 a
Means	3.877 b	5.088 a	5.600 a	

-4Yield of one plant

The results of Table 12 showed the effect of adding vermicompost fertilizer and mycorrhiza fungus on plant yield. The Vermocompost level 3 (V3) addition significantly outperformed the comparison treatment (V1) and Level 2 (V2) with an increase of 141.39 and 30.37% respectively.

The results of the same table showed that the treatment of adding mycorrhiza during cultivation (M3) significantly outperformed the other coefficients, as the percentage of increase in the yield of one plant was 143.14% compared to the non-addition treatment (M1.(

The results of the interference between the addition of vermicompost fertilizer and mycorrhiza fungus indicated that all interference coefficients outweighed the comparison treatment, except for the interference coefficient (V1M2). The interaction treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed all the interference coefficients as well as the comparison treatment and gave the highest yield per plant amounted to 575.7 g, while the yield of one plant in the comparison treatment decreased to 105.26 g.

Table 12. Effect of adding vermicompost fertilizer and mycorrhiza fungu on the yield of one plant (g(

Treatment	V1	V2	V3	Means
M1	105.26 f	192.41 de	e205.71 de	167.79 c
M2	160.89 ef	324.02 c	429.73 b	304.88 b
M3	235.60 d	412.60 b	575.70 a	407.97 a
Means	167.25 c	309.68 b	403.72 a	

-5Total yield

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The results of Table 13 showed the effect of adding vermicompost fertilizer and mycorrhiza fungus on the total yield. The treatment of adding vermicompost fertilizer at the third level (V3) significantly outperformed the comparison treatment (V1) and the second level (V2) with an increase of 141.38 and30.36 % respectively.

The results of the same table showed that the treatment of adding mycorrhiza during cultivation (M3) significantly outperformed the other coefficients, as the percentage of increase in the total yield was 143.13% compared to the non-addition treatment (M1.(

The results of the interference between the addition of vermicompost fertilizer and mycorrhiza fungus indicated that all interference coefficients outweighed the comparison treatment. The interaction treatment between the addition of the third level of vermicompost fertilizer with the addition of mycorrhiza fungus during cultivation (V3M3) significantly outperformed all the interference coefficients as well as the comparison treatment by giving the highest total yield of 3214.27 g, while the total yield in the comparison treatment decreased to 838.05 g.

Table 13. Effect of adding vermicompost fertilizer and mycorrhiza fungus on total plant yield (g(

Treatment	V1	V2	V3	Means
M1	838.05 f	1531.92 de	1637.81 de	1335.92 C
M2	1280.97 ef	2579.77 c	3421.41 b	2427.38 B
M3	1875.79 d	3285.03 b	4583.59 a	3248.13 A
Means	1331.60 C	2465.57 B	3214.27 A	

Tables (4, 5, 6, 7, 8) show that the addition of vermicompost fertilizer led to a significant increase in most of the vegetative growth qualities of the pepper plant. The reason for this increase is due to the fact that vermicompost fertilizer contains a large amount of nutrients and is easy to decompose and release into the soil, which results in an increase in the readiness of nutrients and their absorption by the plant. Leading to the construction of an efficient vegetative total as a result of the availability of the necessary nutrients and the increase of chlorophyll, protein and vitamin C, which led to an increase in vital activities and an increase in the products of carbon metabolism in the leaves, and this can be inferred from the results of the above tables and thus an increase in the availability of manufactured materials, which reflected positively on most of the vegetative qualities of the pepper plant such as plant height, number of leaves, number of branches, stem diameter, leaf area, wet and dry weight of the vegetative total, wet and dry weight of the root system. These results are consistent with the study conducted by [2] on increasing the vegetative and root growth qualities of the plant as a result of the addition of vermicompost fertilizer, as this is due to the

activity of earthworms leading to an increase in oxins and hormones such as gibberellins, which leads to an increase in those qualities of the plant.

These findings are consistent with recent studies that have indicated that the addition of mycorrhiza to the roots of the pepper plant improved vegetative growth qualities [8,13]. The increase in the vegetative and root qualities of the pepper plant when adding mycorrhiza fungus to the roots of the pepper plant is due to the fact that the fungus works to prepare the plant with water
and nutrients it needs through its fungal strands [7]. [12] indicated that the possession of mycorrhiza of fungal filaments led to an increase in the surface area of the roots of the pepper plant, which leads to an increase in its susceptibility to nutrients necessary for its vegetative and root growth. This matches what [18] concluded in their study on mycorrhiza fungus added to the soil. Therefore, the impact of the overlapping factors has become a moral and positive impact of the studied qualities as a result of the importance that is unique to each factor.

The results of the tables (9, 10, 11, 12, 13) show that the addition of vermicompost fertilizer resulted in significant differences in the characteristics of the yield, as a result of the fact that vermocompost fertilizer is one of the most appropriate non-chemical plant nutrition sources that have a positive effect on the growth qualities and yield of the plant, as well as stimulating and increasing the absorption of nutrients by the plant, which was shown by the results of the experiment in tables (4, 5, 6, 7, 8), which led to the activation of construction processes and increase vegetative qualities and thus These results are consistent with the findings of [5,9] that there was an increase in tomato yield when using vermicompost fertilizer, and are consistent with the results of [11] who obtained the highest increase in potato tuber yield by increasing the levels of addition of vermucopost fertilizer.

The results of the aforementioned tables showed that the addition of mycorrhiza showed significant differences in the yield qualities of the pepper plant compared to the comparison, where mycorrhiza fungi work through the vital reactions of root fungi from converting the formula of elements that are not available for absorption to a formula that is easily absorbed by the plant with a positive change in soil properties, and this is what the results of tables (4, 5, 6, 7 and 8) showed, and thus the effect was reflected on the amount of absorbed elements and substances formed in the leaves of the plant, which resulted in an increase in Values of vegetative traits All of the factors mentioned improved yield traits when adding mycorrhiza, which is consistent with the findings of [1]. As well as increasing the total yield of fruits and improving its quality [3 .[

Conclusion

Adding vermicompost with mycorrhizal fungi has a significant impact on improving the growth characteristics, and yield of pepper plants .

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