Effect of cultivation methods, adding organic fertilizers and spraying nanofertilizers on some qualitative traits, available and absorption of elements of broad bean (*Vicia Faba* L.(

Ali Karim Hussein, Hamid Kadhim Abdel Amir, Ahmed Hassan Fadel

Al-Musaib Technical College, Al-Furat Al-Awsat Technical University

Abstract

The experiment was conducted in the 2023-2024 agricultural season in Al-Saddah district, Al-Mahnawiyah region (21 km) north of Babylon province. The experiment included three factors, the first was cultivation methods in two ways (plots and furrow), the second was three levels of organic matter (cow waste), namely (0, 20, 40 tons ha-1), and Table (2) shows their traits, and the third was spraying three levels of nano-fertilizers (without Spraying and spraying nano-cobalt and nano-iron spray at concentrations (zero, 40 mg L-1, 40 mg L-1).Cultivation methods (Furrow method) excelled in qualitative traits, available and absorption of elements by recording the highest averages for the studied traits, where the percentage of protein in the seeds reached (17.05%), carbohydrates (20.86%), available cobalt in the soil (0.39) mg kg soil-1, available iron In the soil (4.84) mg kg soil1-, cobalt absorbed in the plant (2.330) mg kg dry matter-1 and iron absorbed in the plant (181.82) mg kg dry matter-1 respectively.The treatment of adding organic fertilizer to the experiment (40 tons ha-1) excelled in the qualitative traits, available and absorption of elements by recording the highest averages for the studied traits, as the percentage of protein in the seeds reached (17.01%, carbohydrates (21.22%), available cobalt in the soil (0.49) mg kg Soil-1, available iron in the soil (5.29) mg kg soil-1, cobalt absorbed in the plant (2.630) mg kg dry matter-1 and iron absorbed in the plant (178.60) mg kg dry matter-1 respectively.The results of nanofertilizer spraying showed that (nano-iron) excelled in the qualitative traits, available and absorption of elements by recording the highest averages for the studied traits, where the percentage of protein in the seeds reached (16.90%, carbohydrates (20.99%), available cobalt in the soil (0.41) mg kg soil-1, available iron in the soil (4.81) mg kg soil-1, cobalt absorbed in the plant (2.337) mg kg dry matter-1 and iron absorbed in the plant (178.98) mg kg dry matter- 1 respectively.The bi- interaction treatment between the cultivation type and the addition of organic fertilizer (Furrow method and the addition of organic fertilizer at a level of 40 tons ha-1) was significantly excelled on the rest of the bi- interactions in terms of qualitative traits, available, and absorption of elements, by recording the highest averages for the traits studied above.The triple combination between cultivation methods, adding organic fertilizers, and spraying nano-fertilizers significantly excelled in the qualitative traits, available, and absorption of elements, as the combination between (the furrow method, the level of 40 tons ha-1, and nano-iron) gave the highest averages for the traits studied above.

Keywords: broad bean, furrow method, cultivation methods, nano-fertilizers.

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Introduction

Cultivation methods are important for preparing the appropriate cradle for the plant to grow and thus give a good yield. Cultivation methods for crops are known as the processes by which seeds or seeds are placed in such a way that the most appropriate conditions are created for them to germinate and for the seedlings to continue to grow well [2]. There are many methods of manual or mechanical cultivation, depending on the type of crop, the consistency and salinity of the soil, the date of cultivation, the ease of conducting agricultural service operations, the irrigation system, and the level of the land. It is no secret to those working in the agricultural field that organic matter has a role in improving the physical properties of the soil, related to permeability, porosity, movement of water and air in the soil, the spread and penetration of roots, and retention of moisture and soil heat. This physical improvement can be harnessed in particular in the plant production of field crops [7]. Nanofertilizers were used to fertilize plants to reduce traditional mineral fertilizers added to the soil, reduce its pollution with fertilizer and pesticide residues, and preserve the environment. Nanofertilizers are a type of fertilizers made from organic and mineral materials that are compatible with the environment and plants and have a role in increasing nutrient efficiency and reducing soil toxicity and the unguided use of mineral fertilizers [3].Broad bean Vicia faba L. belongs to the legume family (Fabaceae), which is one of the largest and most diverse families. Broad bean seeds contain a high percentage of protein and also contain amino acids, dietary fiber, carbohydrates, (45-30) iron, zinc, In addition to antioxidants, saponins, and some phenolic [10]. The study aims to know the effect of cultivation methods, adding organic matter and spraying nano-fertilizers and their interaction on some qualitative traits, available and absorption of some nutrients and growth of broad bean plants.

Materials and methods:

The experiment was carried out in the 2023-2024 agricultural season in Al-Saddah district, Al-Mahnawiyah region (21 km) north of Babylon provainc. The first experiment is located within a circle of latitude 32° 39′ 12″ north and longitude 44° 16′ 40″ east. Random samples were taken from different locations of the field soil for both locations. At a depth of (0-30 cm) for the purpose of conducting some physical and chemical analyzes on them. Table (1) shows the physical and chemical traits of the field soil. The first experiment included three factors, the first was cultivation methods in two ways (plots and furrow), the second was three levels of organic matter (cow waste), namely (0, 20, 40 tons ha-1), and Table (2) shows their traits, and the third was spraying three levels of nano-fertilizers (without Spraying and spraying nano-cobalt and nano-iron spray at concentrations (zero, 40 mg L-1, 40 mg L-1.(

Soil preparation and experiment implementation:

For both experiments, the soil was plowed with two perpendicular plows using Mold-board plows, and smoothed with disc harrows. After that, the process of leveling and amending was conducted on it. The land of each experiment was divided into three sectors (replicates), each sector containing 18 experimental units, so the number of units for each experiment became (54) experimental units, and it was an area The experimental unit is 12 m2 (4 m * 3 m). The experimental units

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for cultivation methods were divided into (plots and furrows). The distance between one replicate and another is 0.75 m and between one plant and another is 0.25 m. I left a distance of two meters as a separation limit between the experimental units and a distance of two meters between one replicate and another in order to Crop service: For both experiments, organic fertilizers (cow manure) were added to the soil directly before cultivation, by making a longitudinal incision under the seeds during cultivation. Broad bean seeds were planted on 10/16/2023. Two seeds were placed in each hole after germination. The hole was reduced to one plant after the plant reached a height of (10-15) cm [5]. Nitrogen fertilization was carried out in an amount of 80 kg N1 - in the form of 46% urea fertilizer, the first 30 days after cultivation, the second 30 days after the first batch. As for phosphate fertilizer, an amount of 80 kg N1 - was added in the form of triple superphosphate (P2O5). 21%) in one batch before cultivation. As for potassium, it was added at a rate of 120 kg H1 - in the form of potassium sulfate fertilizer 41.5% K2O [4.[

While the nano-fertilizers were sprayed (according to each experiment) on 30 days after cultivation, each worker was sprayed three times between one spraying and the next, 20 days apart. The date of the first spraying was on 11/16/2023, that is, after the appearance of 8 leaves. The second spraying was on 2023. /12/6. The third and final spraying was on 12/26/2023. The spraying process was carried out early in the morning to avoid the damage of high temperatures and drying of the leaves. Zahi was added to the solution as a diffuser. It was sprayed using a 16-litre backpack sprayer.

Experimental design

The two field experiments were conducted in a randomized complete block design (R.C.B.D) with three replications, and the averages are compared using the Least Significant Difference (LSD) test under a probability level of 0.05 [6

Table (1) shows the physical and chemical traits of the field soil for the experiment

values	units	traits
7.6		Soil pH
	$DS.m^{-1}$	Electrical conductivity ECe
21.4	$centimole.charge.kg^{-1}$	Cation exchange capacity (CEC).
19.7	**%**	Soil content of carbonate minerals
1.4	**%**	Calcium sulfate CASO4.2H2O
8.3	$g.kg^{-1}$	Organic matter OM
1.79	$mg.kg^{-1}$ soil	available cobalt
3.76	$mg.kg^{-1}$ soil	available iron
34.2	$mg.kg^{-1}$ soil	available nitrogen
8.5	$mg.kg^{-1}$ soil	available phosphorus
142.6	$mg.kg^{-1}$ soil	available potassium
0.86	$mg.kg^{-1}$ soil	available zinc
416	$g.kg^{-1}$	sand
365	$g.kg^{-1}$	silt
219	$g.kg^{-1}$	Clay
Clay loam	Texture	

Table (2) traits of manufactured organic matter (agriogran powder(

Manufactured organic matter (agriogran powder(	
	Composition
19%	Organic carbon C
32%	Organic matter
3%	Total humic acid

Studied traits:

:1

Percentage of protein in seeds: A sample of seeds was taken randomly when calculating the seed yield for each experimental unit. It was dried, then the seeds were ground and taken from the ground form, and the percentage of protein was calculated in the following equation: - Percentage of protein in seeds % = N concentration In seeds * 6.25 according to [1[

:2Percentage of carbohydrates in seeds: The percentage of carbohydrates was estimated using a spectro photometer at a wavelength of 490 nm [1.[

-3Iron absorbed by the plant (mg/kg dry matter(

Plant samples of 0.5 g are taken from the leaves and at the flowering stage and digested using a mixture of (HNO_3 - $HCLO_4$) in a ratio of 1-2. Then the elements in the filtrate are estimated using an atomic absorption device.

Atomic Absorption Spectrophotometer and calculated the wavelength of each element according to the method of Cresser and Parson, 1979.

-4Available iron: Available iron is extracted with the chelate DTPA 0.005 M and ammonium bicarbonate NH_4HCO_3 1.0 M. The available Fe is measured using a spectrophotometer according to Soltanpour and Schwab, 1977.

-5Available cobalt

The available heavy elements in the soil were determined by extracting them using a mixture consisting of Diethylene Triamine Penta Acetate (DTPA) at a concentration of 0.005 molar with 0.01 molar calcium chloride and 0.1 molar Tri Ethanol amine, with a reaction degree of 7.3 and a ratio of 1:1 (soil: extraction solution) and according to the described method. By (Norvell and Lindsay, 1978) then the element was estimated in the extraction solution using an atomic absorption spectrophotometer. After the end of the experiment, we take soil samples for both experiments and measure their physical and chemical traits according to the previous methods. We also measure the following plant traits according to the methods described.

-6Absorbed cobalt: The total content of heavy elements was estimated after digesting the vegetative samples with a mixture of two acids (H_2SO_4-$HCLO_4$) by taking 0.5 grams of the dried sample, sifted through a sieve with a diameter of 2 mm, placing it in a 250 ml Pyrex bottle, then adding 5 ml of acid. Concentrated sulfuric (H_2SO_4) and left for 24 hours. Then the samples were placed on a hot plate at a temperature of 80°C for an hour. The samples were cooled air-wise and 3 ml of perchloric acid $HCLO_4$ was added at a temperature of 180°C for 2-3 hours. Then they were filtered with filter paper and the volume was completed to 50 ml with water. The distilled substance was then measured to determine the heavy elements using an atomic absorption device [9.[

Results:

protein %

Table (3) indicates that there is a significant effect of cultivation methods on the percentage of protein in seeds. Cultivation methods excelled on furrow by giving it the highest average ability of 17.05%, while cultivation methods in plots gave the lowest average ability of 13.86%. The results of the same table indicate that organic fertilizer (40 tons ha-1) was significantly excelled, giving the highest average for this characteristic, amounting to 17.01%, while (the control treatment) gave the lowest average, amounting to 14.14%. The results of nano-fertilizers indicate a significantly excelled of this trait, as nano-iron excelled by giving the highest average for the trait, amounting to 16.90%, while the (control treatment) gave the lowest average, amounting to 13.89%. The results of the bi- interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 19.21%, while the bi- combination between (cultivation in plots and the control treatment) gave the lowest average. It reached 12.84%. The results showed a significant effect between cultivation methods and nanofertilizers, where the bi- interaction between (cultivation on furrow with nano-iron) gave the highest average, amounting to 19.00%, while the bi- combination between the cultivation method (in plots and the control treatment) gave the lowest average, amounting to 12.34%. The bi- interaction between organic and nano-fertilizers gave a significant effect on the trait, as the level (40 tons-ha-1 with nano-iron) gave the highest average, amounting to 19.81%, while the bi- interaction between (the two control treatments) gave the lowest average, amounting to 13.63%. The results of the same table indicate a significant effect of the triple interaction, as the combination cultivation methods (on furrow, organic fertilizer 40 tons ha-1, and nano-iron) gave the highest average, amounting to 23.27%, while the combination (cultivation in plots and the control treatments for organic and nano-fertilizer) gave the lowest average, amounting to 12.08%. .

Table (3) Effect of cultivation methods, adding organic fertilizers, and spraying nano fertilizers on protein(%)

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
15.43	15.91	15.20	15.18	Without adding	furrow
16.50	17.81	17.01	14.69	20	
19.21	**23.27**	17.92	16.46	40	
12.84	13.27	13.18	**12.08**	Without adding	plots
13.93	14.81	14.59	12.38	20	
14.80	16.34	15.50	12.57	40	
0.212	0.368			**L. S. D $_{(0.05)}$**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
17.05	**19.00**	16.71	15.44	furrow	
13.86	14.81	14.42	**12.34**	plots	
0.123	0.212			L. S. D $_{(0.05)}$	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / Organic fertilizers	
14.14	14.59	14.19	**13.63**	Without adding	
15.22	16.31	15.80	13.54	20	
17.01	**19.81**	16.71	14.51	40	
0.150	0.260			**L. S. D $_{(0.05)}$**	
	16.90	15.57	**13.89**	average	
	0.150			**L. S. D $_{(0.05)}$**	

carbohydrates %

Table (4) indicates that there is a significant effect of cultivation methods for this trait. Cultivation methods excelled on Furrow by giving it the highest average ability of 20.86%, while cultivation methods in plots gave the lowest average ability of 17.28%. The results of the same table indicate that organic fertilizer (40 tons ha-1) was significantly excelled, giving the highest average for this characteristic, amounting to 21.22%, while (the control treatment) gave the lowest average, amounting to 17.42%. The results of nano-fertilizers indicate a significantly excelled of this trait, as nano-iron excelled by giving the highest average for the trait, amounting to 20.94%, while the (control treatment) gave the lowest average, amounting to 16.98%. The results of the bi- interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 23.16%, while the bi- combination between (cultivation in plots and the control treatment) gave the lowest average. It reached 15.58%. The results showed a significant effect between cultivation methods and nanofertilizers, as the bi- interaction between (cultivation on furrow with nano-iron) gave

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the highest average, amounting to 23.56%, while the bi- combination between the cultivation method (in plots and the control treatment) gave the lowest average, amounting to 15.84%. The bi- interaction between organic and nano-fertilizers gave a significant effect on the trait, as the level (40 tons-ha-1 with nano-iron) gave the highest average, amounting to 22.73%, while the bi- interaction between (the two control treatments) gave the lowest average, amounting to 15.87%. The results of the same table indicate a significant effect of the triple interaction, where the combination cultivation methods (on furrow, organic fertilizer 40 tons ha-1, and nano-iron) gave the highest average, amounting to 24.78%, while the combination (cultivation in plots and the control treatments for organic and nano-fertilizer) gave the lowest average, amounting to 15.17%. .

Table (4) Effect of cultivation methods, adding organic fertilizers, and spraying nano-fertilizers on carbohydrate(%)

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
19.26	23.29	17.91	16.57	Without adding	furrow
20.17	22.61	20.33	17.56	20	
23.16	**24.78**	24.44	20.26	40	
15.58	16.15	15.41	**15.17**	Without adding	plots
16.99	18.13	17.34	15.50	20	
19.27	20.68	20.30	16.84	40	
0.343	0.594			**L. S. D (0.05)**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
20.86	**23.56**	20.89	18.13	furrow	
17.28	18.32	17.68	**15.84**	plots	
0.198	0.343			L. S. D (0.05)	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / Organic fertilizers	
17.42	19.72	16.66	**15.87**	Without adding	
18.58	20.37	18.84	16.53	20	
21.22	**22.73**	22.37	18.55	40	
0.242	0.420			**L. S. D (0.05)**	
	20.94	19.29	**16.98**	average	
	0.242			**L. S. D (0.05)**	

Available cobalt in soil (mg kg-1 soil(

Table (5) indicates that there is a significant effect of cultivation methods for this trait. Cultivation methods excelled on furrow by giving it the highest average of 0.39 mg kg-1 soil, while cultivation methods in plots gave the lowest average of 0.33 mg kg-1 soil. The results of the same table indicate the superiority of fertilizer. Organic (40 tons ha-1) showed the highest average for this trait, which amounted to 0.49 mg kg-1 soil, while

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(the control treatment) gave the lowest average, which amounted to 0.25 mg kg-1 soil. The results of nano-fertilizers indicate a significantly excelled for this trait, as nano-iron excelled by giving it the highest average for the trait, amounting to 0.41 mg kg-1 soil, while the (control treatment) gave the lowest average, amounting to 0.30 mg kg-1 soil. The results of bi- interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 0.55 mg kg-1 soil, while the bi- combination of (cultivation in plots and the control treatment) gave the lowest average of 0.24 mg kg-1 soil. The results showed a significant effect between cultivation methods and nanofertilizers, as the bi- interaction between (cultivation on furrow with nano-iron) gave the highest average, amounting to 0.46 mg kg-1 soil, while the bi- combination between the cultivation method (in plots and the control treatment) gave the lowest average, amounting to 0.28 mg kg-1 soil. The bi- interaction between organic and nano-fertilizers gave a significant effect on the trait, as the level (40 tons ha-1 - with nano-iron) gave the highest average amounting to 0.59 mg kg-1 soil, while the bi- interaction between (the two control treatments) gave the lowest average amounting to 0.24 mg kg-1 soil. The results of the same table indicate a significant effect of the triple interaction, as the combination cultivation methods (on furrow and organic fertilizer 40 tons ha-1 and nano-iron) gave the highest average of 0.70 mg kg-1 soil, while the combination (agriculture in plots and the two control treatments for organic fertilizer) gave the lowest average was 0.22 mg kg-1 soil

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Table (5) The effect of cultivation methods, adding organic fertilizers, and spraying nano-fertilizers on the quality of available cobalt in the soil (mg kg-1 soil(

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
0.26	0.28	0.26	0.25	Without adding	furrow
0.36	0.40	0.38	0.30	20	
0.55	**0.70**	0.57	0.39	40	
0.24	0.27	0.24	**0.22**	Without adding	plots
0.31	0.35	0.31	0.28	20	
0.42	0.48	0.44	0.35	40	
0.016	0.028			**L. S. D (0.05)**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
0.39	**0.46**	0.41	0.31	furrow	
0.33	0.37	0.33	**0.28**	plots	
0.009	0.016			L. S. D (0.05)	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / Organic fertilizers	
0.25	0.27	0.25	**0.24**	Without adding	

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0.34	0.37	0.35	0.29	20
0.49	**0.59**	0.51	0.37	40
0.012	0.020			**L. S. D $_{(0.05)}$**
	0.41	0.37	**0.30**	average
	0.012			**L. S. D $_{(0.05)}$**

Cobalt absorbed in plants (mg kg1 - dry matter(

Table (6) indicates that there is a significant effect of cultivation methods for this trait. Cultivation methods excelled on furrow by giving it the highest average of 2.330 mg kg dry matter1-, while cultivation methods in plots gave the lowest average ability of 1.939 mg kg dry matter1-. The results of the same table indicate that organic fertilizer (40 tons ha-1) was significantly excelled by giving the highest average for this characteristic, amounting to 2.630 mg kg dry matter-1, while the (control treatment) gave the lowest average, amounting to 1.744 mg kg dry matter-1. The results of nano-fertilizers indicate a significantly excelled of this trait, as nano-iron excelled by giving the highest average for the trait, amounting to 2.337 mg kg dry matter-1, while the (control treatment) gave the lowest average, amounting to 1.947 mg kg dry matter-1. The results of bi-interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 2.894 mg kg dry matter-1, while the bi- combination between (cultivation in plots and its treatment) gave The lowest average was 1.642 mg kg dry matter-1. The results showed a significant effect between cultivation methods and nanofertilizers, as the bi- interaction between (cultivation on furrow with nano-iron) gave the highest average, amounting to 2.520 mg kg dry matter-1, while the bi- combination between the cultivation type (in plots and the control treatment) gave the lowest average, amounting to 1.778. mg kg dry matter1-. The bi- interaction between organic and nano-fertilizers gave a significant effect for the trait, as the level (40 tons ha-1- with nano-iron) gave the highest average amounting to 2.891 mg kg dry matter1-, while the bi- interaction between (the two control treatments) gave the lowest average. It amounted to 1.641 mg kg dry matter1-. The results of the same table indicate a significant effect of the triple interaction, as the combination cultivation methods (on furrow, organic fertilizer 40 tons ha-1, and nano-iron) gave the highest average of 3.072 mg kg-1 dry matter, while the combination (cultivation in plots and the control treatment of organic and nano-fertilizer) gave the lowest an average of 1.545 mg kg dry matter1.-

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Table (6) The effect of cultivation methods, adding organic fertilizers, and spraying nano-fertilizers on the quality of cobalt absorbed in the plant (mg kg dry matter-1(

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
1.845	1.932	1.866	1.738	Without adding	furrow
2.250	2.555	2.215	1.980	20	
2.894	**3.072**	2.982	2.629	40	
1.642	1.725	1.656	**1.545**	Without adding	plots
1.808	2.027	1.759	1.638	20	
2.366	2.709	2.237	2.152	40	
0.041	0.071			**L. S. D (0.05)**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
2.330	**2.520**	2.354	2.115	furrow	
1.939	2.154	1.884	**1.778**	plots	
0.024	0.041			L. S. D (0.05)	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / Organic fertilizers	
1.744	1.829	1.761	**1.641**	Without adding	
2.029	2.291	1.987	1.809	20	
2.630	**2.891**	2.609	2.390	40	
0.029	0.050			**L. S. D (0.05)**	
	2.337	2.119	**1.947**	average	
	0.029			**L. S. D (0.05)**	

Available iron in soil (mg kg-1 soil(

Table (7) indicates that there is a significant effect of cultivation methods for this trait. Cultivation methods excelled on furrow by giving it the highest average of 4.84 mg kg soil1 - while cultivation methods in plots gave the lowest average of 4.02 mg kg soil1. The results of the same table indicate the excelled of Organic fertilizer (40 tons ha-1) significantly increased by giving the highest average for this trait, which amounted to 5.29 mg kg soil-1, while (the control treatment) gave the lowest average, which amounted to 3.37 mg kg soil-1. The results of nano-fertilizers indicate a significantly excelled for this trait, as nano-iron excelled by giving it the highest average for the characteristic, amounting to 4.81 mg kg-1 of soil, while the (control treatment) gave the lowest average of 3.96 mg kg-1 of soil. The results of bi-interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 5.94 mg kg-1 of soil, while the bi- combination of (cultivation in plots and the control treatment) gave the lowest average of 3.26 mg kg of soil-1. The results showed a significant effect between cultivation methods and nanofertilizers, as the bi- interaction

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between (cultivation on furrow with nano-iron) gave the highest average, amounting to 5.27 mg kg-1 - of soil, while the bi-combination between the cultivation method (in plots and the control treatment) gave the lowest average, amounting to 3.80 mg. kg of soil1-. The bi- interaction between organic and nano-fertilizers gave a significant effect on the trait, as the level (40 tons ha-1- with nano-iron) gave the highest average of 5.91 mg kg of soil1-, while the bi- interaction between (the two control treatments) gave the lowest average of 3.25 mg. kg of soil1-. The results of the same table indicate a significant effect of the triple interaction, as the combination cultivation methods (on furrow and organic fertilizer 40 tons ha-1- and nano-iron) gave the highest average of 6.50 mg kg of soil1-, while the combination (agriculture in plots and the two control treatments for organic fertilizer) gave And nano) the lowest average was 3.23 mg kg soil-1.

Table (7) The effect of cultivation methods, adding organic fertilizers, and spraying nano-fertilizers on the quality of available iron in the soil (mg kg-1 soil(

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
3.49	3.61	3.58	3.27	Without adding	furrow
5.10	5.71	5.38	4.20	20	
5.94	**6.50**	6.41	4.91	40	
3.26	3.31	3.25	**3.23**	Without adding	plots
4.14	4.42	4.10	3.91	20	
4.65	5.32	4.35	4.27	40	
0.053	0.092			**L. S. D $_{(0.05)}$**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
4.84	**5.27**	5.12	4.13	furrow	
4.02	4.35	3.90	**3.80**	plots	
0.031	0.053			L. S. D $_{(0.05)}$	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / Organic fertilizers	
3.37	3.46	3.42	**3.25**	Without adding	
4.62	5.07	4.74	4.06	20	
5.29	**5.91**	5.38	4.59	40	
0.037	0.065			**L. S. D $_{(0.05)}$**	
	4.81	4.51	**3.96**	average	
	0.037			**L. S. D $_{(0.05)}$**	

Iron absorbed in plants (mg kg dry matter-1(
Table (8) indicates that there is a significant effect of cultivation methods for this trait. Cultivation methods excelled on furrow by giving it the highest average of 181.32 mg kg dry matter1-, while cultivation methods in plots gave the lowest average ability of 156.93

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mg kg dry matter1-. The results of the same table indicate that organic fertilizer (40 tons ha-1) was significantly excelled by giving the highest average for this characteristic, amounting to 178.60 mg kg dry matter-1, while the (control treatment) gave the lowest average, amounting to 156.49 mg kg dry matter-1. The results of nano-fertilizers indicate a significantly excelled of this trait, as nano-iron excelled by giving the highest average for the trait, amounting to 178.98 mg kg dry matter-1, while the (control treatment) gave the lowest average, amounting to 157.71 mg kg dry matter-1. The results of bi-interaction between cultivation methods and organic fertilizers showed a significantly excelled. The combination between cultivation methods (on furrow and 40 tons ha-1) excelled on the rest of the combinations and gave the highest average of 191.21 mg kg dry matter-1, while the bi- combination between (cultivation in plots and its treatment) gave The lowest average was 147.61 mg kg dry matter-1. The results showed a significant effect between cultivation methods and nanofertilizers, as the bi- interaction between (cultivation on furrow with nano-iron) gave the highest average, amounting to 186.31 mg kg-1 dry matter, while the bi- combination between the cultivation type (in plots and the control treatment) gave the lowest average, amounting to 141.18. mg kg dry matter1-. The bi-interaction between organic and nano-fertilizers gave a significant effect for the trait, as the level (40 tons ha-1- with nano-iron) gave the highest average amounting to 192.46 mg kg dry matter1-, while the bi- interaction between (the two control treatments) gave the lowest average. It amounted to 148.85 mg kg dry matter1-. The results of the same table indicate a significant effect of the triple interaction, as the combination cultivation methods (on furrow, organic fertilizer 40 tons ha-1, and nano-iron) gave the highest average of 197.11 mg kg-1 dry matter, while the combination (cultivation in plots and the control treatment of organic and nano-fertilizer) gave the lowest. An average of 140.67 mg kg dry matter1.-

Table (8) The effect of cultivation methods, adding organic fertilizers, and spraying nano-fertilizers on the quality of iron absorbed in the plant (mg kg dry matter 1(-

average	Nanofertilizers (mg(			Organic fertilizers (tons.h-1	cultivation methods
	Nano iron	Molybdenum	Without spraying		
165.37	170.89	168.21	157.02	Without adding	furrow
187.36	190.94	190.64	180.51	20	
191.21	**197.11**	191.34	185.19	40	
147.61	152.10	150.05	**140.67**	Without adding	plots
157.21	175.06	155.83	140.73	20	
165.99	187.81	168.03	142.13	40	
2.337	4.049			**L. S. D (0.05)**	
average	Nano iron	Molybdenum	Without spraying	Nanofertilizers / cultivation methods	
181.32	**186.31**	183.40	174.24	furrow	
156.93	171.66	157.97	**141.18**	plots	
1.350	2.337			L. S. D (0.05)	
	Nano iron	Molybdenum	Without	Nanofertilizers	

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average			spraying	Organic fertilizers
156.49	161.49	159.13	**148.85**	Without adding
172.29	183.00	173.23	160.62	20
178.60	**192.46**	179.69	163.66	40
1.653	2.863			**L. S. D $_{(0.05)}$**
	178.98	170.68	**157.71**	average
	1.653			**L. S. D $_{(0.05)}$**

Discussion:

The results of tables (3, 4, 5, 6, 7, 8) indicate that there is a significant effect. The reason may be due to the importance of organic additions in improving soil properties, and to the ability of organic matter to hold mineral elements in a chelated manner due to the effectiveness of their active groups (humic and fulvic). The organic waste improved soil moisture and the efficiency of using added fertilizers, which reflected positively on the rate of absorption of major and minor molecules by the plant, including nitrogen, which is an essential element in the process of building and manufacturing amino acids and proteins within plant tissues [3]. It is clear from the results presented in the tables above that spraying nano-iron fertilizer led to an increase in the soil content of available elements N, P, K, F, and Zn, and this could be due to the role of nano-iron in increasing the activity of enzymes that contribute to building cells as a result of the effective metabolism. Photosynthesis, as iron is included in the synthesis of the enzyme Ferrodoxin, and this enzyme is a carrier of electrons, which in turn accelerates the process of photosynthesis, which leads to an increase in growth indicators, which include the plant’s vegetative and nuclear traits. In addition, spraying iron led to a significant increase in the weight of the fresh and dry roots, and this is what It helps in absorbing the largest amount of available elements, and this in itself affects the elemental balance of available elements in the soil in the area confined between the soil components and the absorption areas on the roots, which prompts the materials carrying these elements, such as organic matter and clay separation, to release these elements into the soil solution, which It increases their available [8] and the increase in iron elements may be due to its inclusion in the synthesis of the nitrogenase enzyme, which is important in the process of nitrogen fixation. The reason for the increase in iron may be due to the effect of the ability of the leguminous plant to reduce iron to ferrous iron on the surfaces of its roots. Or the secretion of reduced organic compounds Siderophores that help prepare this element [12]. The increase in concentrations of macro- and microelements may be attributed to the role of cobalt in the synthesis of vitamin B12 and its reflection on the increase in the action of nitrogen fixation, which leads to a greater physiological action within the plant, such as increasing the effectiveness of the process of photosynthesis, protein synthesis, etc., and this leads to better growth, which requires greater absorption of important nutrients. for this physiological process [12.[

The increase in concentrations of macro- and microelements may be due to the role of cobalt in the synthesis of vitamin B12 and its effect on increasing the action of nitrogen fixation, which leads to greater physiological action within the plant, such as increasing the effectiveness of the process of photosynthesis, protein synthesis, etc. These lead to better growth, which requires greater absorption of important nutrients. for this physiological process [12.[

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