The effect of spraying with nan iron and gibberellic acid on the chemical traits of *Moringa oleifera* seedlings growing in two agricultural medium.

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Abstract

The experiment was conducted at the Agricultural Research and Experiments Station of the College of Agriculture / University of Kirkuk (Alsiyada field) in Kirkuk province, during the growing season (2019-2020).In order to study the effect of spraying with nano chelated iron at a concentration of (4,2,0) g / litre and gibberellin (500,250,0) ml /L, on some chemical traits of Moringa plants using two agricultural medium (sandy loam soil and loamy sand soil). Sowing seeds on the date (3/1/2019) in polyethylene bags, The seedlings were sprayed with nano iron and gibberellin until complete wetness by using 0.01% of liquid soap as a diffuser on two dates, the first on (15/11/2019) of the nano iron element and (17/11/2019) of gibberellic acid and the second spraying on (1 / 2/2020) of nano iron and (3/2/2020) of gibberellic acid, The experiment was designed by Randomized Complete Block Design (RCBD) according to the split-plot system and with three replications. As each experimental unit included 5 pots, The results obtained can be summarized: The use of sandy loam soil had a significant effect in increasing the percentage of protein, phosphorus and iron, and the medium had no significant effect on the vegetative and root traits and the percentage of nitrogen, potassium and carbohydrates in the leaves. The concentration of 2 g / L of nano iron led to a significant increase in the percentage of phosphorous and potassium in the leaves, while the concentration exceeded 4 g / L in the percentage of carbohydrates, and the comparison treatment was excelled on the percentage of iron. The effect of 250 ml/L of gibberellin significantly affected the percentage of nitrogen ,protein and phosphorous, potassium and iron, while the control treatment was excelled in the percentage of carbohydrates.

Key words: agricultural medium, nano iron, gibberellin.

تأثير الرش بالحديد النانوي وحامض الجبرليك في الصفات الكيميائية لشتلات المورينجا *Moringa oleifera* النامية في وسطين زراعيين

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الخلاصة

أجريت هذا الدراسة في محطه البحوث والتجارب الزراعية في كلية الزراعة/جامعه كركوك (حقل الصيادة) في محافظه كركوك، خلال موسم النمو (2019-2020)، بهدف دراسة تأثير الرش بـنانو الحديد المخلبي بتركيز (0،2،4) غم/لتر والجبرلين (0،250،500) مل/لتر، في بعض الصفات الكيميائية لنبات المورينجا باستخدام وسطين زراعيين (تربة رملية مزيجية و تربة مزيجية رملية) حيث تم زراعة البذور في تاريخ (1/3/2019) في اكياس بولي اثيلين، ورشت الشتلات بالحديد النانو والجبرلين حتى البلل التام باستخدام

0.01% من الصابون السائل كمادة ناشرة في موعدين الأول بتاريخ (2019/11/15) من عنصر الحديد النانوي و(2019/11/17) من حامض الجبرليك والرشة الثانية بتاريخ (2020/2/1) من الحديد النانوي و(2020/2/3) من حامض الجبرليك، نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة وفق نظام الالواح المنشقة بثلاث قطاعات إذ اشتملت كل وحدة تجريبه 5 سنادين، يمكن تلخيص النتائج التي تم الحصول عليها: أن استخدام التربة الرملية المزيجية أثر معنوياً في زيادة النسبة المئوية للبروتين والفسفور والحديد، ولم يكن للأوساط تأثيراً معنوياً في الصفات الخضرية والجذرية ونسب النيتروجين والبوتاسيوم والكربوهيدرات في الاوراق. التركيز2 غم/لتر من الحديد النانوي أدى الى زيادة معنوية في نسبة الفسفور والبوتاسيوم في الاوراق، بينما تفوق التركيز 4 غم/لتر في نسبة الكربوهيدرات، وتفوق معاملة المقارنة في نسبة الحديد، أثر التركيز 250 مل/لتر من الجبرلين معنوياً في النسبة المئوية للنيتروجين والبروتين والفسفور والبوتاسيوم والحديد، بينما تفوق معاملة المقارنة في نسبة الكربوهيدرات.

الكلمات المفتاحية: اوساط زراعية، حديد نانوي، جبرلين.

Introduction

Moringa oleifera L. is one of 13 species of trees belonging to the genus Morina, which is the only genus in the Moringaceae family. Moringa spreads in Africa, especially in Ethiopia, Kenya and Sudan. It grows in tropical regions, its origin is from India, but it is known in central Africa (21),It has high economic importance as it is used as a foodstuff because it contains high levels of carbohydrates, protein and minerals such as (magnesium, potassium, iron, zinc and phosphorous) and is rich in nutrients, especially in its leaves, and thus can be used to combat malnutrition diseases, especially among infants and pregnant women (19), It is also used in biofuels because Moringa seed oil contains a high percentage of unsaturated fatty acids and it meets all the main specifications of the biodiesel standards of the United States of America, Germany and Europe(22) and it works to withdraw pollutants from the water such as heavy metals and pesticides (15). Nanofertilizers have unique features due to their small size and large surface area that lead to an increase in the absorption surface and thus high carbon representation and increase the production of active substances in the plant (28), Iron is one of the necessary micro-elements that the plant needs when adding iron to Moringa plants, which leads to the preservation of the green substance, so it enters into the formation of chlorophyll and is not included in the composition and also enters into the formation of cytochromes of importance in the process of carbon Photosynthesis and respiration, Where iron plays a major role in Converting the dissolved nitrogen in Moringa leaves into protein, and its protein function is to protect chlorophyll from intense sunlight (1), Iron is one of the necessary micro-elements that the plant needs when adding iron to Moringa plants, which leads to the preservation of the green substance, so it enters into the formation of chlorophyll and is not included in the composition and also enters into the formation of cytochromes of importance in the process of carbon Photosynthesis and respiration, Where iron plays a major role in Converting the dissolved nitrogen in Moringa leaves into protein, and its protein function is to protect chlorophyll from intense sunlight (1), Phytohormones have an effective role in increasing growth and active organic materials for many plants. Gibberellins are phytohormones that stimulate plant growth. They are naturally found in all plants of the plant kingdom. Growing tops, new leaves, clumpy fruits and newly developing seed germs are a major source of these compounds.The physiological effect of gibberellins is due to their control of enzymatic activities and their activation of metabolism processes. Treatment with gibberellins contributes to the transformation of nutrients to a greater degree towards growth sites (34). The agricultural community is important in preparing and providing water and nutrients necessary for growth as well as stabilizing plants (13), It is important for the agricultural medium used in the nurseries and greenhouses to have good ventilation of the root system, as well as the

availability of water and nutrients and its light weight (4). The present study aimed to study the effect of spraying with chelated iron nanoparticles at a concentration of (2,0,4) g / L and gibberellin. (500,250,0) ml/L in some mineral characteristics of Moringa plants, using two agricultural medium (sandy Loam soil and Loamy sand soil).

Materials and methods

The experiment was conducted at the Agricultural Research and Experiments Station of the College of Agriculture / University of Kirkuk (Alsiyada field) located at (latitude 42.35 ° and longitude 37.44 °) and it started from 1/3/2019 to 1/5/2020, where the seeds were cultivated. Dated 1/3/2019 in polyethylene bags, The seedlings were sprayed with nano iron and gibberellin until complete wetness by using 0.01% of liquid soap as a diffuser on two dates, the first on (15/11/2019)of the nano iron element and (17/11/2019) of gibberellic acid and the second spraying on (1 / 2/2020) of nano iron and (3/2/2020) of gibberellic acid, The experiment was designed by Randomized Complete Block Design (RCBD) according to the split-plot system and with three replications. The main plot included two types of the agricultural medium while the subplot occupied (3) levels of nano iron and the sub-sub plot occupied (3) levels of gibberellin. Analyze the data using a multiple Dunkin test. Limits To compare averages, soil samples were taken from pot plants before cultivated, The analyzes were conducted in the Agriculture Directorate in Kirkuk (Laboratories Department) to reveal its physical and chemical traits, which are described in Table (1).

Table (1) Some physical and chemical traits of the soil sample used in cultivation

The final result of soil 2	The final result of soil 1	Units	Traits
0.119	0.126	%	Nitrogen (N)
2.038	2.575	PPM	Phosphorous (P)
48.14	48.143	PPM	Potassium (K)
0.09	0.38	$Mmho.cm^{-1}$	EC
8.10	8.02		PH
60	220	PPM	TDS
1.497	6.258	Meq/L	Ca
0.722	4.608	Meq/L	Mg
Loamy sand	Sandy loam		Texture
12	6	%	Clay
12	10	%	Silt
76	84	%	Sand

Studied traits

1. **traits of vegetative growth**

1.1. Plant height (cm).

Measure with a tape measure from the soil surface from the pots to the top of the plant.

1.2. Estimation of Mineral Contents of Leaves

The plant samples of leaves were digested according to method (11) by weighing 1 g of ground dry matter and put it in a glass digestion flask with a capacity of 100 ml and add 5 ml of concentrated sulfuric acid (H_2SO_4) and 1 ml of perchloric acid ($HCLO_4$) as an aid. Put the beaker on the heating plate. The temperature was raised gradually (until the solution became clear), then the beaker was cooled and the volume was completed to 20 ml by adding

distilled water. After that, the elements were evaluated according to the following methods:

2. The Percentage of Nitrogen in the Leaves

The percentage of nitrogen in the digested samples was measured according to method (10) using the Microkjeldhal distillation apparatus.

2-2: Protein Percentage Leaves.

The percentages of protein in Moringa leaves were calculated according to the following equation:

Protein (%) = nitrogen (%) x 6.25 (31).

2-3: Phosphorus Percentage in Leaves.

The percentage of phosphorous in the digested leaves plant samples was estimated using the color method and using a Spectrophotometer (Libra-Bichron 2005 UK-S22) to measure the visible density of phosphorus at a wavelength of 620 nm (25).

2-4: Potassium Percentage in Leaves.

The percentage of potassium in the digested samples was estimated according to the method (14) using the Atomic Absorption spectroscopy (Perkin Elmer 5000, USA) of American origin, as the wavelength of potassium was measured at 766.5 nm and calibrated with the standard curve of potassium.

2-5: Estimation of iron content in leaves ($\mu g.g^{-1}$).

The iron element was estimated for the digested leaves samples using an atomic spectrometer at a wavelength of 248.3 nm and calibrated with the measurement curve of iron (30).

2-6: Estimation of carbohydrates percentage (%)

The percentage of total carbohydrates was estimated in the papers and the readings were recorded using a Spectrophotometer type (V-100 EMC lab 100) with a wavelength of 490 nm, according to (6).

Results and discussion

1. Plant height (cm).

The results of the statistical analysis in Table (1) showed a significant effect when using gibberellin on plant height for Moringa, The use of gibberellin at a concentration of 250 ml/ L caused a significant increase in the plant, where it gave the highest average of 89.26 cm, while the use of the concentration 500 ml/ L caused a significant decrease in plant height, where it gave the lowest average of 64.12 cm, and the agricultural medium and nano iron had no effect. Significant in plant height. the bi-interaction between the agricultural medium and gibberlin, showed that the treatments involving 250 ml/ L and sandy loam soil recorded the highest plant height with an average of 90.85 cm compared to the rest of the treatments, and the interaction between agricultural medium and nano Iron did not show any significant effect in this traits .As for the interaction between gibberellin and nano Iron, it showed a significant effect on this traits, where the highest plant height reached 94.28 cm at a concentration of 250 ml/ L of gibberellin and 2 g / L of nano iron compared to the rest of the concentrations and by treating 500 ml/ L of gibberellin and 4 g/ L of iron. The nano iron gave the lowest plant height of 58.81 cm. The triple interaction of study factors showed that gibberellin at a concentration of 250 ml/ L with nano iron at a concentration of 2 g/ L, and both medium had the highest plant height of 95.44 cm in sandy loam soil and 93.11 cm in sandy loam soil compared to all other treatments.

Table (1) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on plant height (cm) of Moringa seedlings in different agricultural medium.

		Nano iron(C) (mg/L)			gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
a 78.16	c b 77.62	c - a 74.77	– a 79.44 c	– a 78.66 c	0(mg/L) (b1)	sandy Loam soil (a1)
	a 90.85	b a 88.11	a 95.44	b a 88.99	(b2) 250(mg/L)	
	d c 66.02	c 60.63	– a 70.78 c	c b 66.66	(b3) 500(mg/L)	
a 75.18	c b 75.66	– a 72.44 c	– a 78.77 c	– a 75.77 c	0(mg/L) (b1)	Loamy sand soil (a2)
	b a 87.66	– a 81.55 c	a 93.11	b a 88.33	(b2) 250(mg/L)	
	d 62.22	c 57.00	c b 67.00	c 62.66	(b3) 500(mg/L)	
	gibberellic acid average (B)	a 74.50	a 81.89	a 78.10	sandy Loam soil (a1)	C × A
		a 70.33	a 79.63	a 75.59	Loamy sand soil (a2)	
	b 76.64	– b 73.61 e	– a 79.11 d	– b 77.22 d	0(mg/L) (b1)	C × B
	a 89.26	c - a 84.83	a 94.28	b a 88.66	(b2) 250(mg/L)	
	c 64.12	e 58.81	– c 68.89 e	e d 64.66	(b3) 500(mg/L)	
			a 72.42	a 80.76	a 76.85	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

2. The percentage of nitrogen in the plant (%).

Table (2) showed a significant effect of gibberellin in the percentage of nitrogen content in leaves, where it gave the highest percentage of 1.74% when using 250 ml/ L of gibberellin compared to the lowest concentration of 500 ml/ L of gibberellin, which amounted to 1.25%. agricultural medium , nano Iron and their interactions had any significant effect on nitrogen content. The bi-interaction between the agricultural medium and gibberellin indicates a significant increase in the nitrogen content, which reached 1.76% when using 250 ml/ L of gibberellin in sandy loam of soil compared to other combinations and with the lowest combination of 500 ml / L of gibberellin in both medium .It was found that the interaction of 250 ml/ L of gibberellin with 2 g/ L of nano iron resulted in a significant increase in nitrogen content, which reached 1.83% compared to the lowest combination of 1.14% consisting of 500 ml / L of gibberellin with 4 g / L of Nano iron.The results of the triple interaction between the study factors show its significant effect on this traits. When using sandy loam soil with a concentration of 250 ml / L of gibberellin and 2 g / L of nano iron achieved a significant increase of 1.89% compared to the lowest percentage of 1.14% in the combination of 500 ml/ L of gibberellin with 4 g / L of nan iron in sandy loam soil and 1.11% in Loamy sand soil.

Table (3) showed that the use of sandy loam soil had a significant effect on the protein content, which gave the highest percentage 9.49% compared to loamy sand soil. As for the use of gibberellin, it had a significant effect on the trait, where it recorded the highest percentage of 10.87% at concentration. 250 ml / L of gibberellin, compared to other concentrations, and the lowest percentage of 7.83% when using 500 ml / L of gibberellin, and nano iron did not have any significant effect on this trait.The same table showed the significant effect of the bi-interaction between the media and gibberellin, where the combination of 250 ml / L of gibberellin and sandy loam soil achieved the highest protein content, which reached 11.03% compared to the lowest percentages when 500 ml / L of gibberellin interaction in both medium, and that the interaction of 250 ml/ L of gibberellin with 2 g / L of nano iron significantly excelled on the percentage of protein, where it recorded the highest percentage of 11.43% compared to the lowest percentage when the combination of 500 ml / L of gibberellin with 4 g / L of nan iron amounted to 7.15%, The interaction of chelated iron with the medium had no significant effect on this trait. The results of the triple interaction between the study factors show its significant effect on this trait . When using 250 ml / L of gibberellin and 2 g / L of nano iron in sandy loam, a significant increase was reached by 11.84% compared to the lowest percentage of interaction 500 ml / liter Gibberellin with 4 g / L of nano iron in sandy loam soils which amounted to 7.35% and in the same combination in loamy sand soils which amounted to 6.94%.

Table (2) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the nitrogen content in leaves of Moringa seedlings in different agricultural medium.

				Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
1.52 a	1.53 a-b-c	1.43a-b-c	1.58 a-b-c	1.56 a-b-c	0 (mg/L) (b1)	sandy Loam soil (a1)
	1.76 a	1.63 a-b-c	1.89 a	1.76 a-b	250 (mg/L) (b2)	
	1.27 c	1.18 c	1.37 a-b-c	1.25 b-c	500 (mg/L) (b3)	
1.48 a	1.47 b-c	1.41 a-b-c	1.57 a-b-c	1.44 a-b-c	0 (mg/L) (b1)	Loamy sand soil (a2)
	1.71 a-b	1.63 a-b-c	1.76 a-b	1.74 a-b	250 (mg/L) (b2)	
	1.24 c	1.11 c	1.37 a-b-c	1.24 b-c	500 (mg/L) (b3)	
	gibberellic acid average (B)	1.41 a	1.62 a	1.53 a	sandy Loam soil (a1)	A × C
		1.38 a	1.57 a	1.47 a	Loamy sand soil (a2)	
	1.50 b	1.42 b-c-d-e	1.57 a-b-c-d	1.50 a-b-c-d	0 (mg/L) (b1)	C × B
	1.74 a	1.63 a-b-c	1.83 a	1.75 a-b	250 (mg/L) (b2)	
	1.25 c	1.14 e	1.37 c-d-e	1.25 d-e	500 (mg/L) (b3)	
			1.40 a	1.59 a	1.50 a	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

3. The percentage of protein in the leaves (%).

Table (3) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the percentage of protein in the leaves of Moringa seedlings in different agricultural medium.

				Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
9.49 a	9.54 a-b	8.95 a-b-c	9.88 a-b-c	9.78 a-b-c	0 (mg/L) (b1)	sandy Loam soil (a1)
	11.03 a	10.21 a-b-c	11.84 a	11.03 a-b	250 (mg/L) (b2)	
	7.91 c	7.35 c	8.58 a-b-c	7.81 b-c	500 (mg/L) (b3)	
9.22 b	9.19 b-c	8.80 a-b-c	9.80 a-b-c	8.98 a-b-c	0 (mg/L) (b1)	Loamy sand soil (a2)
	10.71 a-b	10.21 a-b-c	11.03 a-b	10.90 a-b	250 (mg/L) (b2)	
	7.76 c	6.94 c	8.58 a-b-c	7.76 b-c	500 (mg/L) (b3)	
	gibberellic acid average (B)	8.84 a	10.10 a	9.54 a	sandy Loam soil (a1)	A × C
		8.65 a	9.80 a	9.21 a	Loamy sand soil (a2)	
	9.36 b	8.87 b-c-d-e	9.84 a-b-c-d	9.38 a-b-c-d-e	0 (mg/L) (b1)	C × B
	10.87 a	10.21 a-b-c	11.43 a	10.96 a-b	250 (mg/L) (b2)	
	7.83 c	7.15 e	8.58 d-e	7.78 d-e	500 (mg/L) (b3)	
			8.74 a	9.95 a	9.38 a	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

4. The percentage of phosphorous in the plant (%).

Table (4) that the use of study factors and interactions had a significant effect on the percentage of phosphorus in the leaves, where sandy loam soil was significantly higher in the percentage of phosphorus in leaves, which amounted to 0.63% compared to the lowest percentage of 0.58 in loamy sand soil and that the use of 250 ml / L of gibberellin was significantly excelled on the other treatments, which amounted to 0.78% compared to the lowest percentage of 0.41% at the concentration of 500 ml / L of gibberellin, and it was found that the use of 2 g / L of nano iron had a significant effect on these trait where it gave the highest percentage 0.68% compared to the concentration of 4 g / L which gave the lowest percentage of 0.31%. The results of the bi-interaction in the same table indicate that the interaction of 250 ml/L of gibberellin with sandy mixing soil had a significant effect on the phosphorus percentage, which gave the highest percentage of 0.81% compared to other combinations.As for the interaction of the medium with nano iron, it was found that the use of 2 g / L of nan iron in sandy loam soil gave the highest percentage of 0.72% compared to all other combinations, and that the interaction of gibberellin and nano iron had a significant effect on this trait, where it gave the highest percentage of 0.85. % when 250 ml / L of gibberellin interaction with 2 g /L of nan iron compared to other treatments. The triple interaction of study factors in the same table showed that the combination of 250 ml / L of gibberellin with 2 g / L of nano iron and sandy loam soil had a significant effect on phosphorus percentage, which reached the highest percentage of 0.88% compared to other combinations.

5. The percentage of potassium in the plant (%).

Table (5)showed that the use of gibberellin at a concentration of 250 ml / L led to a significant increase in the percentage of potassium in the leaves, which reached the highest average of 1.42% compared to the lowest percentage when using the concentration of 500 ml /L of gibberellin, which reached 0.75%.The spraying (0 and 2) g /liter and nano iron was excelled which gave the highest percentage of 1.13% and 1.19%, respectively. concentration of 4 g /L, significantly excelled on the lowest percentage of 0.99%. It had no significantly effect in this trait. The bi-interaction between gibberellin and the medium indicated that it had a significant effect on the potassium percentage, where the use of 250 ml / L of gibberellin in both medium led to a significant increase, reaching 1.43% in sandy loam and reaching 1.41% in loamy sand soil compared to other combinations, where it was less the percentage in the combination is 500 ml / L of gibberellin and in both medium, There was an interaction between the nano iron and the media when spraying 2 g / L of nano iron was found in both medium, where it reached 1.20% in sandy loam soil and reached 1.18% in loamy sand soil compared to the lowest average of 0.96% in the component combination From 4 g / L in loamy sand soil, The results of the interaction between gibberellin and chelated iron showed a significant effect on the potassium percentage, which reached a maximum of 1.43% when 250 ml / L of gibberellin interaction with no spraying of chelated iron and 1.46% at 2 g / L of chelated iron compared to the lowest average of 0.65%. When 500 ml / L of gibberellin with 4 g /L chelated iron, The triple interaction in the results of the same table of study factors showed that the interaction of 250 ml / L of gibberellin with 2 g / L of nan iron in both medium gave the highest average of 1.46% compared to other combinations.

Table (4) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the percentage of phosphorous in leaves of Moringa seedlings in different agricultural medium.

				Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
0.63 a	0.64 c	0.57 j	0.74 c-d	0.61 e- f	0 (mg/L) (b1)	sandy Loam soil (a1)
	0.81 a	0.76 c	0.88 a	0.78 b	250 (mg/L) (b2)	
	0.44 e	0.31 r	0.53 g	0.47 o	500 (mg/L) (b3)	
0.58 b	0.59 d	0.55 j-g	0.63 e	0.6 f	0 (mg/L) (b1)	Loamy sand soil (a2)
	0.75 b	0.72 d	0.81 b	0.73 d	250 (mg/L) (b2)	
	0.39 f	0.3 r	0.48 o	0.39 u	500 (mg/L) (b3)	
	gibberellic acid average (B)	0.55 e	0.72 a	0.62 c	sandy Loam soil (a1)	A × C
		0.52 f	0.64 b	0.57 d	Loamy sand soil (a2)	
	0.62 b	0.56 e	0.69 c	0.61 d	0 (mg/L) (b1)	C × B
	0.78 a	0.74 b	0.85 a	0.76 b	250 (mg/L) (b2)	
	0.41 c	0.31 g	0.51 f	0.43 j	500 (mg/L) (b3)	
			0.54 c	0.68 a	0.60 b	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

Table (5) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the percentage of potassium in leaves of Moringa seedlings in different agricultural medium.

				Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
1.12 a	1.17 b	0.98 c-d-e	1.3 a-b	1.24 a-b-c	0 (mg/L) (b1)	sandy Loam soil (a1)
	1.43 a	1.37 a-b	1.46 a	1.45 a	250 (mg/L) (b2)	
	0.77 c	0.68	0.84 e - f –j	0.8 e - f– j	500 (mg/L) (b3)	
1.08 a	1.11 b	0.92 d-e - f	1.26 a-b-c	1.15 b-c-d	0 (mg/L) (b1)	Loamy sand soil (a2)
	1.41 a	1.35 a-b	1.46 a	1.41 a-b	250 (mg/L) (b2)	
	0.72 c	0.61 j	0.83 e- f –j	0.73 e- f– j	500 (mg/L) (b3)	
	gibberellic acid average (B)	1.01 b-c	1.20 a	1.16 a-b	sandy Loam soil (a1)	A × C
		0.96 c	1.18 a	1.10 a-b-c	Loamy sand soil (a2)	
	1.14 b	0.95 c	1.28 a-b	1.20 b	0 (mg/L) (b1)	C × B
	1.42 a	1.36 a-b	1.46 a	1.43 a	250 (mg/L) (b2)	
	0.75 c	0.65 d	0.84 c-d	0.77 c-d	500 (mg/L) (b3)	
			0.99 b	1.19 a	1.13 a	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

6- The percentage of iron in the plant (%).

The results of the statistical analysis in Table (6) showed a significant effect on the percentage of iron in the leaves of the Moringa plant, where the use of sandy loam soil had a significant effect, where it gave the highest percentage of 71.30% compared to the loam sand soil, which gave the lowest percentage of 68.56%, and that the use of gibberellin at a concentration of 250 ml /L had a significant effect on the percentage of iron in the leaves, where it reached a maximum of 84.72%, while the use of the concentration 500 ml / L caused a significant decrease in the percentage of iron, which recorded 57.56%, and it was found that the use of 4 g / L of nano iron had an effect Significant in the percentage of iron, where it reached the highest average of 74.78% compared to the control treatment, which gave the lowest average of 65.83%.The bi-interaction between the agricultural medium of gibberellin showed that the treatments involving 250 ml / L and sandy loam soils recorded the highest percentage of iron 86.67% compared to the rest of the combinations, where the lowest percentage was when 500 ml /L of gibberellin interaction with both medium. The interaction between media and nano iron showed a significant effect on this traits, where it gave the highest percentage of 76.67% when the combination of 4 g / L with sandy loam of soil compared to the lowest percentages when control treatment in both medium. As for the interaction between gibberellin and nano iron, it showed a significant effect on this trait, where the highest percentage reached 90.83% when the concentration of 250 ml / L of gibberellin and 4 g / liter of nano iron compared to the rest of the concentrations was treated with 500 ml / L of gibberellin and (0 and 2).) g / L of nano iron, which gave the lowest percentage (55.83 and 57.50%), respectively, The triple interaction significant of study factors showed that gibberellin at a concentration of 250 ml / liter with nano iron at a concentration of 4 g / L of nan iron in sandy loam gave the highest percentage of 93.33% compared to other combinations and the lowest percentage of 55.00% at 500 ml / L of Gibberellin in interaction with control treatment of nano iron in loamy sand soils.

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7. The percentage of carbohydrates in the plant (%).

The results of the statistical analysis in Table (7) indicate the effect of gibberellin on the amount of carbohydrates manufactured in the Moringa plant, which reached a maximum of 18.09% for the plant treated with the control treatment compared to the lowest average of 17.89% when treated with 500 ml / L of gibberellin. The reason for the control treatment of nano iron also had a significant effect on this trait, which reached the highest average of 18.03% compared to the lowest percentage of 17.94% when treated with a concentration of 2 g / L of nan iron, and the medium had no significant effect in this trait. The bi-interaction between gibberellin and the medium showed a significant effect on the amount of carbohydrates absorbed, where it gave the highest percentage when compared to both medium, where it was 18.09% in sandy loam soil and 18.08% in loamy sand soil. It was found from the interaction between the nan iron and the medium that the control treatment in both medium was significantly excelled to the other combinations, where it reached 18.04% in sandy loam and 18.02% in loamy sand compared to other combinations.

Table (6) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the percentage of iron in leaves of Moringa seedlings in different agricultural medium.

			Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)	
71.30 a	68.89 c	76.67 d-e	66.67 f-j	63.33 j-g -o	0 (mg/L) (b1)	sandy Loam soil (a1)
	86.67 a	93.33 a	86.67 b-c	80.00 d	250 (mg/L) (b2)	
	58.33 d	60.00 g-o-u-r	58.33 o-u-r	56.67 u-r	500 (mg/L) (b3)	
68.56 b	66.11 c	71.67 e - f	65.00 j-g	61.67j-g-o-u	0 (mg/L) (b1)	Loamy sand soil (a2)
	82.78 b	88.33 a-b	81.67 c - d	78.33 d	250 (mg/L) (b2)	
	56.78 d	58.67 o-u-r	56.67 u-r	55.00 r	500 (mg/L) (b3)	
	gibberellic acid average (B)	76.67 a	70.56 b-c	66.67 d	sandy Loam soil (a1)	A × C
		72.89 b	67.78 c-d	65.00 d	Loamy sand soil (a2)	
	67.50 b	74.17 d	65.83 e	62.50 e	0 (mg/L) (b1)	C × B
	84.72 a	90.83 a	84.17 b	79.17 c	250 (mg/L) (b2)	
	57.56 c	59.33 f-j	57.50 j	55.83 j	500 (mg/L) (b3)	
			74.78 a	69.17 b	65.83 c	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability level.

Table (7) The effect of spraying with different concentrations of chelated nano iron and gibberellic acid on the carbohydrate ratio of Moringa seedlings in different agricultural medium

				Nano iron(C) (mg/L)	gibberellic acid(B)	agricultural medium(A)
agricultural medium average(A)	A X B	4 (c3)	2 (c2)	0 (c1)		
17.99 a	18.09 a	18.10 b	18.03 c	18.15 a	0 (mg/L) (b1)	sandy Loam soil (a1)
	17.98 b	17.97 d-e -f	17.96 e -f	18.01 c-d-e	250 (mg/L) (b2)	sandy Loam soil (a1)
	17.90 c	17.88 j	17.86 j	17.95 f	500 (mg/L) (b3)	
17.98 a	18.08 a	18.08 b	18.02 c-d	18.14 a	0 (mg/L) (b1)	Loamy sand soil (a2)
	17.96 b	17.96 e -f	17.95 f	17.97 d-e -f	250 (mg/L) (b2)	
	17.88 c	17.87 j	17.85 j	17.93 f	500 (mg/L) (b3)	
	gibberellic acid average (B)	17.99 b	17.95 c-d	18.04 a	sandy Loam soil (a1)	A × C
		17.97 b-c	17.94 d	18.02 a	Loamy sand soil (a2)	
	18.09 a	18.09 a-b	18.02 c	18.15 a	0 (mg/L) (b1)	C × B
	17.97 b	17.97 d-e	17.96 e	17.99 c-d	250 (mg/L) (b2)	
	17.89 c	17.88 f	17.85 f	17.94 e	500 (mg/L) (b3)	
			17.98 b	17.94 c	18.03 a	Nano iron average(C)

A = agricultural medium , B = gibberellic acid, C = nano iron.

The values with similar letters for the single factor or their interactions individually did not differ significantly according to the Duncan polynomial test under the probability level of the 5% probability leve.

Discussion

The results showed that the concentrations of nano iron, gibberellin and sandy loam and their interaction had a significant effect on the vegetative and chemical growth traits of Moringa seedlings, that the use of sandy loam resulted in a significant increase in all the studied trait. The reason for this may be due to the fact that the basis for the use of different agricultural medium in which millions of microorganisms live that contribute to supplying the plant with the nutrients that work to analyze and prepare them to be absorbed by plants and their growth becomes stronger (18). The increase in plant height, Table (1), as a result of the increase in nano iron concentrations from (0-4 mg / L) is due to the fact that nano iron fertilizers have unique properties of their high surface area and small minutes that lead to increased absorption. The interaction of nano fertilizers affects the ability of Dissolving and diffusion of nutrients and their provision to plants that cause an increase in the carbonate metabolism process (3),The nano iron affects the activity of the enzymes that participate in the process of carbonic representation, where iron enters the composition of Ferredoxin, which acts as a carrier of electrons in the process of carbon representation that stimulates the growth of Moringa trees on the condition that the nanoparticles are added at low concentrations to the solution ((23), the height of the plant increases Table (1) When using a concentration of 250 mg / L of gibberellin, it is due to the main effect of gibberellin in the softness and expansion of cell walls and then its elongation, which led to an increase in plant height (17). The increase in the percentage of nitrogen, phosphorous and potassium elements in Table (2, 4 and 5) as a result of using nano iron is due to the effect of adding low concentrations of nano iron in producing a strong radical group with a high efficiency in absorbing nutrients from the soil in addition to the high absorption of nan iron fertilizers and increasing the area. Surface requirements that require withdrawal of the nutrients necessary to complete the process of carbonization (27) and the results are consistent with (29). For their studies on the Moringa plant, who proved that increasing the concentrations of nano iron increases the concentrations of nutrients in plants. The positive effect of gibberellin in increasing the concentrations of some nutrients such as nitrogen, phosphorus and potassium in Table (2, 4 and 5) compared to the control treatment without addition, where the reason is due to a role Gibberellin increases the rate of Photosynthesis, stomatal conductivity and transpiration average, which leads to an increase in the demand for nutrients from the soil (20). The increase in protein content in the leaves of Moringa trees, the treatment with the increase in the concentration of nano iron, Table (3) is due to the provision of micro-nutrients such as iron and zinc, which leads to an increase in the efficiency of nitrogen use and its absorption from the soil, and then the increase in the polymerization enzymes that contribute to protein synthesis (8)),

Gibberellin has an effective role in encouraging the pathways of the biosynthesis of free amino acids (33), which provides the basic requirements for building proteins, which led to a significant increase in protein percentage, Table (3) when using gibberellin. In addition, gibberellin acid activates the polymerase enzymes that lead to Protein composition (16). That the use of nano iron led to a significant increase in the iron content in the leaves, Table (6), due to the containment of the nano iron chelate compound on the nano iron at a concentration of 9%, which led to an increase in the iron content in the leaves. This result agrees with (12),The increase in the amount of absorption with the increase in gibberellin concentrations is due to the increase in bioactivity in the leaves, which leads to an increase in the demand for nutrients, which leads to an increase in the amount absorbed, due to the additional effect of increasing the biological reactions leading to the production of protein and other vital substances (9) and (24). The decrease in the percentage of carbohydrates in Table (7) for the use of concentrations (2 and 4 mg / L) of nano iron is due to the fact that the use of nano iron led to a significant increase in the element nitrogen Table (2) and a cycle in the intermediate reactions in the TCA cycle to make amino acids that form Protein Table (3), which increased the percentage of carbohydrates at higher concentrations of nano iron (7) The accumulation of carbohydrates is one of the mechanisms of plant adaptation to stress, which plays an important role in maintaining the reduction in the osmotic capacity of Cytosol (5). The use of gibberellin led to a significant decrease in the leaf carbohydrate content, Table (7) due to the plant growth regulators like gibberellin, it works to regulate the biological metabolism in plants, activate the

transport system, and organize between the source and the downstream, in order to transfer carbohydrates from the places of their manufacture to the different parts of the plant, and this leads to a decrease in the percentage of carbohydrates in the leaves (26).

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