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EFFECT OF THE USE OF MICRO-NANO FERTILIZERS, NORMAL MICRO FERTILIZER AND GIBBERELLIC ACID AND THEIR INTERFERENCE IN SOME GROWTH, CHEMICAL, MEDICINAL CHARACTERISTICS AND YIELD IN FENUGREEK (*TRIGONELLA FOENUM GRAECUM* L.)

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Abstract

A field study was conducted in the botanical garden of the Department of Life Sciences - College of Education for Pure Sciences - Ibn Al-Haytham University of Baghdad, for the season 2019-2018 in order to test the efficiency of micrnanoparticles and regular mineral fertilizers and Gibberellic acid and their interactions in some growth and yield characteristics and medicinal compounds for fenugreek (*Trigonella foenum graecum* L.). The experiment was carried out using the design of complete randomized sectors Using three iterations, where three concentrations were used for each of the nano fertilizers (0, 1, 2) $g.l^{-1}$ and regular fertilizers (0, 2, 4) $g.l^{-1}$ and four concentrations of the Gibberellic acid (150, 100, 50, 0) µg-l^{-1}. The results indicated that the concentration of 2 $g.l^{-1}$ from the nano fertilizer and the concentration of 4 $g.l^{-1}$ gave a significant increase in some studied characteristics such as plant height The leafy area, the leaf content of iron and zinc, the percentage of carbohydrates, the number of pods, and the weight of seeds per pod, while the concentration gave 100 µg. $Liter^{-1}$ of the Gibberellic acid significantly increased the above-mentioned characteristics and the percentage of the diosgenin compound. As for the bilateral interaction between the nano fertilizer and the normal fertilizer The concentration gave 2 $g.l^{-1}$ from the nano fertilizer and the concentration of 4 $g.l^{-1}$ from the normal enrichment significantly increased most of the studied characteristics, while the bilateral interaction between the nano-fertilizer and the Gibberellic acid resulted in the two concentrations of 2 $g.l^{-1}$ and 100 µg. l^{-1} respectively, a significant increase in most studied characteristics, and led the two concentrations 4 $g.l^{-1}$ from normal and enriched concentrations 100 µg.l^{-1} of the Gibberellic acid significantly increased most of the studied characteristics. As for the triple overlap between the study coefficients, the concentrations gave 2 $g.l^{-1}$ from enriched Nano fertilizer 4 $g.l^{-1}$ of normal enrichment, and 100 µg.l^{-1} of Gibberellic acid significantly increased most of the characteristics of the study.

Key words : Gibberellic acid, nano fertilizer, fenugreek.

Introduction

Fenugreek plant is one of the existing herbaceous plants and has a plant like clover. It has a root that leads to a bacterium contract. The stem stands up to a length of more than (50) cm depending on the nature of the environment in which it is grown and is considered a winter crop.Its feathery leaves are a three-leaf compound, and the color of its flower is white, which tends to yellowish They are found separately or in two flowers together in the armpits of leaves(Qutb, 1981). The fenugreek plant belongs to the Fabaceae family and belongs to the rank of fabales and to the genus Trigonella and was used in ancient times in African and Asian countries as an important source of the drug (Basu, 2006). Most studies indicate that the hometown of the arena is located in southeastern Europe and the countries located on the Mediterranean and western Asia (Shapiro and Gong, 2002). Fenugreek *Trigonella foenum graecum* L. is a plant of the leguminous family Fabaceae. The scientist Linnaeus indicated that there are about 260 species of fenugreek (Basu, 2006). *Trigonella foenum graecum* L. is the only widely cultivated species of the

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genus Trigonella (Petropoulos, 2002). Fenugreek seeds contain 22% protein and colloidal substances up to 28% and 2-6% static oils containing a percentage of active compounds such as (Trigonelline and Choline). This compound is involved in metabolism(Qutb,1992). Fenugreek leaves and stems are a rich source of calcium, iron, carotene, ascorbic acid and protein(Das, 2007). Recent studies have confirmed that fenugreek seeds contain many active and pharmaceutical compounds, including proteins, fats, carbohydrates, etc. Because of the presence of these ingredients, its nutritional and medicinal benefits have multiplied(Al-Waeli, 2003) . One of the advantages of foliar feeding is its rapid response, through which nutrients can be added according to the need of the plant and its evolutionary stage (Hassan *et al.*,1990) [11] & (Murtic *et al.*, 2012). The soils of central and southern Iraq are basic and contain minerals, carbonates, and clay with high levels that make nutrients less ready for absorption by plants. Here comes the role of foliar spray that makes nutrients more ready for absorption (Hassan *et al.*, 1990). Micronutrients, especially zinc, iron and manganese, play an important role in most enzymatic reactions. They also have an indirect role in the synthesis of many plant growth regulators, which in turn will be reflected in an increase in vegetative growth and produce an increase in its content of chemical compounds and oils (Farooqi *et al.*, 2012). (Mengel and Kirkby, 2005) indicated that boron deficiency is one of the most prevalent types of micronutrient deficiencies and therefore its deficiency will affect the productivity of many important crops. Symptoms of B deficiency appear on developing peaks where they are stunted and occur from the side of the bud toward the base and the growth stops and also impedes the elongation of the apical masters. The stem and leaf holders become thickened, cracked, and corked, and lateral buds encourage growth and fracture of apical dominance, as well as no flowering (Benton, 2003). It was mentioned (Solar, 2001) that adding boron bribes mostly works to ensure that sufficient quantities of it are delivered to the plant, because it helps in fertilization of flowers, holding fruits and early maturing. (Mahler, 2004) Indicated The copper element Cu is one of the necessary elements for the growth and development of the plant and because of its need is a small number of micronutrients, the plant contains 2-20% of copper by dry weight.. Several studies have shown that copper is essential for the work of some breathing enzymes such as ascorbic acid oxidase, cytochrome oxidase and monoamine oxidase. Copper also stimulates seed formation, which is necessary for the growth of reproductive organs and helps the roots to carry out their vital function (Stehouwer and Roth, 2004). Copper is involved in the electronic transmission chain that links the photosynthetic and chemical reaction system to photosynthesis (Hassan *et al.*,1990) . Leguminous crops are rich in iron, so they must meet their needs of this element when cultivated, especially in Iraqi soil, which suffers from a low iron element, due to the low levels of organic matter, as well as a high pH and a state of imbalance between the iron element and some other elements such as Copper and zinc, and that is by replacing iron with these elements, so it reduces the amount of iron that is transported through the roots, so it is preferable that iron be added by way of foliar spray on the plant (Al-Nuaimi , 2000) [27]. Spraying the beans to the iron helped delay aging in the plant (Garg,1986).

Manganese is one of the important minor elements of plants and is found in the form of compounds and may exist in a free form. Manganese is absorbed by the plant in the form of Mn^{+2} (Al-Mousili, 2015) [29]. He mentioned (Lieten, 2004) that a deficiency of manganese may cause an imbalance in the representation of Putin and carbohydrates, as well as the green parts of the plant all need manganese in order to stimulate the different biochemical processes in the plant and that its presence in good proportions is necessary to increase the number of ripe fruits as well as increase the percentage of vitamin C. (Al-Mousili, 2015) He explained that there are many factors that affect the readiness of Zn in the soil, including the degree of PH where zinc is more readily available in acidic soils due to its influence by the calcium carbonate present in large quantities in alkaline soils as well as high levels of phosphate where it is The intense bonding between HPO4 and Zn of other micronutrients affects the readiness of zinc in the soil where there is significant competition between zinc, iron, manganese and copper in high quantities.

Zinc is a specialized component of cytochromate enzymes that the rest of the elements cannot replace. It is necessary for the phosphorylation and formation of glucose. It also maintains the stability of the parts of the ribosomes and controls the amount of water absorbed by the plant, Zinc is important in the manufacture of the amino acid tryptophan and its deficiency affects the formation of pollen (Al-Mousili, 2015).

(Salama *et al.*, 2015) Zn mentioned an important role in many physiological and biochemical processes, where this element is involved in the metabolic reactions of proteins, carbohydrates and growth regulator auxin, as well as it enters in the synthesis of cell membrane structures as it participates in a number of functions of these cells and participates in protecting the cell from

Damage to some Reactive Oxygen Species (ROS). (Rashid and Wafique, 2000) indicated that zinc foliar spray on peas leads to an increase in all yield components, which increases the total seed yield, and helps reduce the toxicity of other elements such as boron.

Nanoparticles used in agriculture include fertilizers that greatly aid plant growth, yield, and pesticides for managing insects and diseases (Sonkaria and Khare, 2012).

Among the sources of minor nanofertilizers are synthetic chelates, such as an EDTA compound abbreviated for ethylene di-amino tetra acetic acid, which consists of a cyclic structure that binds iron, manganese, copper and zinc within its composition, and these compounds are sprayed on the leaf parts where the addition of these compounds to the soil did not exceed.

(Ali and Alamery, 2015).%3-5 when adding to soil, values are greater when spraying leaf.

The plant responds to iron deficiency by stimulating a series of physiological and morphological changes in the roots to facilitate the absorption of Fe present in the root environment despite competition with some microelements. Reducing plant toxicity and iron deficiency brings the need to determine appropriate rates for the use of foliar spray for the iron component, as most agricultural lands have recorded a clear reduction in iron percentage of 30-50%. (Cakmak, 2002).

And the Gibberellic acid is one of the important plant hormones in the growth and development of the plant, as it was mentioned(Shahead, 2003) that Gibberellic acid stimulates stem elongation, widens the leaves, flowering of plants, holding the fruits, and forming the seedless fruits and encourages the first cambium and building protein and nucleic acids, which leads to an increase In the crop.

Most of the active compounds present in the fenugreek plant are more concentrated in seeds than in other parts (Murakami, 2000), including the diosgenin compound that is due to steroidal saponins, The research has focused on studying steroidal saponins for extracting sex hormones from the steroidal structure of the soapy materials, which gives great resemblance to them. For the basic structure of the sex hormone, and for this reason, these compounds of plant origin can be obtained easily and cheaply instead of extracting them from animal origin that is very expensive (Qutb, 1981).

Materials and Methods

The Conducting Experiment

The experiment was conducted in the winter season (2019-2018) in the botanical garden of the College of Education, Ibn Al-Haytham / University of Baghdad, with the aim of determining the response of fenugreek plant to micro-nano fertilizers, non-micro-fertilizers and Gibberellic acid after sprayed leaflessly with the following concentrations (0, 1, 2) g. l^{-1} of fertilizer I Q COMPY consisting of micro nanofertilizers according to its guidance and concentrations (0, 2, 4) g. l^{-1} of non-fertilizer Minor nanoparticles and concentrations (0, 50, 100, 150) µg. l^{-1} of the Gibberellic acid. The experiment was designed according to the design of RCBD (Randomize Complete Block Design) with three replicates (4 × 3 × 3), the first is three concentrations of nanoparticles and the second is three concentrations of non-nano fertilizers And four concentrations of the Gibberellic acid included 118 experimental unit and the area of one repeater 36 m^2 as the area of the experimental unit (1) m^2 (Al-Dujaji, 2010). The seeds were planted on November 29/ 2018, and the service operations were carried out from irrigation and the greenhouse was raised daily to ventilate and continue the hoeing operations of the soil to get rid of weeds.

Treatments Preparation

Concentrations of IQ Compi, which consist of the following microelements, were prepared (Fe 6.24%, Zn 6.11%, Mn 6.05%, Cu 0.52%, B 0.25%, Mo 0.25%) and attended the concentrations (0, 1, 2) This is by dissolving each amount of concentrations in a liter of distilled water to become the concentration The final 1000 µg. l^{-1}, and stirring of the solution continues until complete dissolution, then the concentrations (0, 1.2) g are prepared. L^{-1} of the main focus. The concentrations of the non-nano fertilizers were prepared in the same way in the previous method and with three concentrations (0, 2, 4) g.$l^{-1.}$

Four concentrations of the Gibberellic acid were prepared after weighing the powder with a sensitive scale and adding some drops of NaOH with a little distilled water in a 1 liter container for each concentration, then dissolve Well, complete the volume to 1 liter with distilled water and we will have four concentrations of GA3 (0, 50, 100, 150) µg. l^{-1}.

Treatment Application

Non-manure fertilizer was added in my concentration (2, 4) g. Liters $^{-1}$ in the form of foliar spray when the plant reached six leaves until the wetness of the leaves on the date of 12/24/2018, and on the next day the nano-fertilizer was sprayed on paper At two concentrations (1, 2) g. Liters $^{-1}$ until the leaves are completely wet. After seven days have passed, the leaves are sprayed with GA3 in three concentrations (50, 100, 150) µg. l^{-1}. The 2-hand manual sprinkler was used to carry out the transactions, adding a few drops of diffuse material (brightly) to all the transactions before spraying, to ensure the distribution of solutions (Kirkby and Mengel, 2012). The spraying process was carried out in the early morning for the concentrations used, taking into account the separation of plants with pieces of cardboard during spraying, in order to ensure that there is no overlap between adjacent treatments. The second was added 30 days after the first workshop, and I followed the same steps in the first workshop.

Studied characteristics

Height of plant (cm)

The height of the plant was measured after selecting three random plants from the center of the experimental unit from the soil surface and up to the highest point of the chosen plant using the measuring tape.

Total leaf area (ds^2.$plant^{-1}$)

Total leafy area of the plant: The total leafy area of the plant was measured by means of tablets for three plants taken randomly from the two central planners for each experimental unit, taking 50 tablets with a diameter of 25 mm out of 50 leaves from the three leaves of the plant and then dried the leaves and disks He took its weight and then estimated the total leafy area of the plant using proportion and proportion (Jordan, 1993).

Determination of iron and zinc content (µg. kg^{-1}) in the vegetative population

Minor elements (Fe and Zn) were measured using the Atomic Absorption Spectrophotometer and by Allan (1960). Method for diagnosing soap steroids (Diosgenin compound) and determining its percentage in fenugreek using high performance liquid chromatography (H. P. L. C) Hight-Performance Liquid Chromatogerphy. The active compound Diosgenin was diagnosed with a Japanese-made HPLC 10AV-LC Shizmadzu equipped with a Shimadzu LC-10A dual delivery pump and peaked with UV-Vis 10 A-SPD spectroscopy, weighed 5 grams of seeds and milled and then soaked in 400 ml Of distilled water and then heat The mixture until it reached 200 ml. Mix 1.2 mol / L of HCl with fenugreek seed extract and heated in a water bath at 80 ° C for one hour. The mixture was extracted by equal volumes of ethyl acetate and centrifuge, then dried under nitrogen gas and the rest thawed in 1 mL of methanol and subjected to H.P.L.C analysis.

Statistical analysis

Use a randomized Complete Block Design (RCBD) design according to a global organization for a Factorial experiment and the coefficient averages were compared using the Least Significant Difference (LSD) test at a probability level of 0.05. Source.

Results

The effect of nano fertilizers, fertilizers, regular fertilizers, and the Gibberellic acid and their interference with some of the appearance of the fenugreek plant :

Average plant height

(Table 1) shows a significant increase in the average height of the plant, as the concentration exceeded 2 g. 1 liter of enriched nanoparticles (nano fertilizer for microelements), giving it the highest average plant height of 159.52 cm, with an increase of 15.07% compared to untreated plants. The treatment of the use of the normal fertilizer showed a significant difference, and the concentration gave 4 gm. l^{-1} of the non-nano fertilized significantly increased and the highest value of the average height of the plant as it reached 7.99% compared to untreated plants. The treatment of the use of the Gibberellic acid showed a significant difference, and the concentration recorded 100 µg. l^{-1} of the Gibberellic acid increased significantly, reaching 156.63 µg. l^{-1}, with an increase of 12.01% compared to untreated plants. The treatment of bilateral interference between the nano fertilizer and the normal showed a significant increase in the average height of the plant, where the treatment recorded 2 g. 1 liter of enriched nanoparticles and 2 g. l^{-1} of the normal fertilized positive response and gave the highest average interference of 164.38 cm and an increase of 30.89% compared to untreated plants. The results of the interaction between the Gibberellic acid and nano fertilizer showed a significant difference in the average height of the plant and the treatment was 2 gm. l^{-1} from the nano fertilizer and 100 µg. l^{-1} Gibberellic acid had the highest average height of the plant reached 167.36 cm and the increase rate was 36.44 compared to untreated plants. The results of the bilateral interaction between the normal fertilizer and the Gibberellic acid showed a significant superiority, as the treatment recorded 4 g. l^{-1} from the normal fertilizer and 100 µg. l^{-1} of the Gibberellic acid the highest value of the average height of the plant was 161.98 cm, and an increase of 27.20% compared to untreated plants. The treatment of triple interference between the nano fertilizer and the normal fertilizer and the Gibberellic acid showed a significant superiority, where the treatment recorded 2 g.l^{-1} from the nano-fertilizer and 2 g.l^{-1} and 100 µg. An increase of 101.01% compared to untreated plants.

Average of leaf area

(Table 2) shows a significant increase and positive response to treatments in the average leafy area of

Table 1: Effect of nano fertilizers, normal fertilizers, and the Gibberellic acid and their interference in the mean plant height in cm in the fenugreek plant *Trigonella foneum graecum* L .

Nano fertilizer N ($g.l^{-1}$)	Normal fertilizer M ($g.l^{-1}$)	Triple interference G x M x N				Dual interference
		GA_3 (G) ($\mu g.l^{-1}$)				
		0	50	100	150	(M) x (N)
0	0	86.75	136.45	143.15	136.01	125.59
	2	137.20	142.08	146.83	143.05	142.29
	4	144.04	144.76	150.35	143.88	145.76
1	0	142.30	140.34	146.20	147.88	144.18
	2	139.95	146.99	155.06	153.10	148.78
	4	145.94	150.03	166.05	155.31	154.33
2	0	152.96	154.96	158.16	154.94	155.26
	2	157.05	164.03	174.38	162.06	164.38
	4	152.25	159.97	169.53	153.89	158.91
LSD=0.05		16.43				9.700
Dual interference G x N						
Concentration N		**Concentration G ($\mu g.l^{-1}$)**				**Average N**
		0	**50**	**100**	**150**	
0		122.66	144.10	146.78	140.98	138.63
1		142.73	145.79	155.77	152.10	149.10
2		154.09	159.65	167.36	156.96	159.52
LSD=0.05		10.90				4.60
Dual interference G x M						
Concentration M		**Concentration G ($\mu g.l^{-1}$)**				**Average M**
		0	**50**	**100**	**150**	
0		127.34	143.92	149.17	146.28	141.68
2		144.73	151.03	158.76	152.74	151.82
4		147.41	151.59	161.98	151.03	153.00
LSD=0.05		14.41				4.60
Average G		139.83	148.84	156.63	150.01	
LSD=0.05		5.31				

fenugreek plant The concentration exceeded 2 $g.l^{-1}$ from the nano fertilizer by giving it the highest average leaf area of 8.9591 cm 2 and an increase of 18.21% compared to untreated plants. The regular fertilizer treatment recorded a positive response, where the concentration recorded 4 g. l^{-1} of the ordinary fertilizer significantly increased, as the highest value of the average leafy area reached 8.6355 cm2, with an increase rate of 11.25% compared to untreated plants. As for the treatment of the Gibberellic acid, it gave a significant increase, as the treatment recorded 150 µg. l of the Gibberellic acid had the highest concentration of 8.8597 cm^2, with a rate of 24.45% compared to untreated plants. As for the bilateral interaction between the nano fertilizer and the normal fertilizer, it gave a positive response and scored a significant superiority. The treatment was recorded at 2 gm. l^{-1} from the nano fertilizer and 4 gm. l^{-1} from the normal fertilizer. The highest concentration of the average paper area reached 9.2884 cm ^{2}, with an increase of 33% Compared to untreated plants. While the bilateral interaction between the nano fertilizer and the Gibberellic acid showed a significant difference, as the treatment gave 2 $g.l^{-1}$ from the nano-fertilizer and 150 µg. l^{-1} of the Gibberellic acid the highest value for the average paper area reached 9.5416, with an increase of 65.13% compared with untreated plants. The results of the bilateral interaction between the normal fertilizer and the Gibberellic acid showed a significant superiority, where the treatment recorded 4 $g.l^{-1}$ from the normal fertilizer and 150 µg. l^{-1} of the Gibberellic acid the highest concentration, which reached 9.3034 cm ^{2}, with an increase of 48.60% compared to untreated plants. The results of the triple interference indicated a significant superiority, as the treatment had 2 $g.L^{-1}$ from nano computer and 4 $g.l^{-1}$ and 150 µg. l^1 positive interference. Untreated plants.

Appreciate the content of micronutrients

Iron content in the vegetative total of the plant ($\mu g.kg^{-1}$)

(Table 3) The results of the table indicated a significant difference in the iron content in the vegetative group when treating the addition of the nano fertilizer, where the highest concentration was recorded at the treatment of $2g.l^{-1}$ from the nano fertilizer by 1029.21 µg. Kg^{-1}, with an increase of 51.14% compared to Untreated plants. The results of the addition of non-nanofertile enrichment indicated a significant difference where the treatment recorded 4 $g.l^{-1}$ the highest value with an average of 967.03 µg. Kg^{-1}, with an increase of 49.93% compared to the untreated plant. The results of adding the Gibberellic acid showed a significant difference, as the treatment recorded 100 $\mu g.L^{-1}$, the highest value was 1073.81 µg. Kg^{-1}, with an increase of 69.31% compared to the untreated plant. The results of the bilateral interaction between the nano fertilizer and the normal fertilizer showed a positive response and a significant moral difference in the average iron content, where the treatment recorded 2 $g.l^{-1}$ from the nano

Table 2: Shows the effect of nano fertilizer, normal fertilizer and Gibberellic acid and their interference of leaf area (cm. Plant^{-1}) for fenugreek *Trigonella foenum graecum* L.

Nano fertilizer N (g.l^{-1})	Normal fertilizer M (g.l^{-1})	Triple interference G x M x N				Dual interference
		GA$_3$ (G) (µg.l^{-1})				
		0	50	100	150	(M) x (N)
0	0	4.9201	7.3575	7.6815	7.8721	6.9578
	2	5.4360	8.3490	8.5760	8.8031	7.7910
	4	6.9785	8.0801	8.1996	8.6976	7.9889
1	0	6.0680	8.1766	8.8375	8.3715	7.8634
	2	7.7959	8.5512	8.7161	8.5568	8.4050
	4	7.9774	8.8068	8.9204	8.8111	8.6289
2	0	7.7933	8.1691	8.7949	8.8775	8.4087
	2	8.3370	9.1815	9.8557	9.3457	9.1799
	4	8.7653	8.8876	9.0993	10.4015	9.2884
LSD=0.05		1.76				0.88
Dual interference G x M						
Concentration N		**Concentration G (µg.l-1)**				**Average N**
		0	**50**	**100**	**150**	
0		5.7782	7.9287	8.1524	8.4576	7.5792
1		7.2804	8.5115	8.8247	8.5798	8.2991
2		8.2985	8.7461	9.2500	9.5416	8.9591
LSD=0.05		0.65				0.27
Dual interference G x M						
Concentration M		**Concentration G (µg.l^{-1})**				**Average M**
		0	**50**	**100**	**150**	
0		6.2605	7.9011	8.4380	8.3737	7.7433
2		7.1896	8.6939	9.0493	8.9019	8.4587
4		7.9071	8.5915	8.7398	9.3034	8.6355
LSD=0.05		0.87				0.27
Average G		7.1191	8.3955	8.7423	8.8597	
LSD=0.05		0.32				

fertilizer and 2 g.1^{-1} With an increase of 124.86% compared to the untreated plant. The results of the bilateral interaction between the nano fertilizer and the Gibberellic acid indicated a significant difference, where the treatment recorded 2 g.l^{-1} from the nano-fertilizer and 100 µg.l^{-1} of the Gibberellic acid the highest value, which recorded 1374.24 g.kg^{-1}, with a significant increase of 189.24% Compared to untreated plants. The treatment of bilateral interference between the normal fertilizer and the Gibberellic acid showed a significant difference in the average iron content, as the treatment gave 4 g.l^{-1} from the normal fertilizer and 100 µg.l^{-1} g of the Gibberellic acid the highest amount, which amounted to 1199.65 g.Kg-1 and in proportion An increase of 165.85% compared to untreated plants. The results of the triple interference of the treatments showed a positive response with a significant difference in the mean iron content, as the treatment gave 2 g.l^{-1} from nano fertilizer and 2 g.l^{-1} from normal fertilizer and 100 µg. It reached 1714.58 gm kg $^{-1}$, with an increase of 799.57% compared to untreated plants.

Zinc content in the vegetable total (µg.kg^{-1})

(Table 4) The results of the table showed that there was a significant increase in the zinc content in the vegetable total of fenugreek plant, where the addition of nano fertilizer treatment showed a significant difference and gave the treatment 2 g.l $^{-1}$ the highest average of the zinc content reached 312.11 g.kg-1 with a 24.58% increase compared to With untreated plants. The addition of the normal fertilized treatment gave a significant difference, as the transaction recorded 4 g.l^{-1}, the highest average of 296.46 g. kg $^{-1,}$ with an increase of 13.93% compared to untreated plants. The results of the bilateral interactions between the nano fertilizer and the normal fertilizer showed that there were significant differences in the average content of the vegetative group of zinc, as the concentration gave 2 g.l^{-1} from the nano fertilizer and 4 g.l^{-1} from the ordinary enriched 328.35 µg. 46.11% increase compared to untreated plants. The bilateral interaction between the nano fertilizer and the Gibberellic acid was significant, as the concentration gave 2 g.L^{-1} from the nano-fertilizer and 100 µg. l^{-1} of the Gibberellic acid the highest value of the interference reached 365.42 µg. kg $^{-1}$, with an increase of 64.31% compared to untreated plants. And the bilateral interaction between the normal fertilizer and the Gibberellic acid significantly, as the concentration resulted in 4 g.l^{-1} from the regular fertilizer and 100 µg.l^{-1} of the Gibberellic acid with the highest value of the interference amounted to 338.87 µg. Transaction. Triangular interactions between the study parameters indicated a significant difference in the content of the vegetative part of zinc, as the plants outperformed the treated plants in concentrations of 2 g.l^{-1} from the nano fertilizer and 2 g.l^{-1} from the normal fertilizer and 100 µg.l^{-1} of Gibberellic acid hormone, with its highest interfering value, reached 408.21 µg. kg^{-1} and the increase was 131.92% compared

Table 3: Shows the effect of nano- fertilizers, normal fertilizers, their interference, and the Gibberellic acid on iron content in the vegetative(µg.kg^{-1}) system of fenugreek *Trigonella foenum graecum* L.

Nano fertilizer N (g.l^{-1})	Normal fertilizer M (g.l^{-1})	Triple interference G x M x N				Dual interference (M) x (N)
		GA_3 (G) (µg.l^{-1})				
		0	50	100	150	
0	0	190.60	491.11	781.35	620.46	520.88
	2	593.71	750.13	889.67	700.51	733.51
	4	641.05	827.53	931.39	754.28	788.56
1	0	567.11	624.09	849.42	609.88	662.63
	2	683.43	869.95	939.64	969.69	865.68
	4	718.32	881.21	1150.13	1041.24	947.73
2	0	596.04	730.15	890.71	789.51	751.60
	2	790.52	1118.89	1714.58	1060.93	1171.23
	4	927.11	1214.26	1517.42	1000.43	1164.81
LSD=0.05		380.76				196.45

Dual interference G x N

Concentration N	Concentration G (µg.l-1)				Average N
	0	50	100	150	
0	475.12	689.59	867.47	691.75	680.98
1	656.29	791.75	979.73	873.60	825.34
2	771.22	1021.10	1374.24	950.29	1029.21
LSD=0.05	214.49				63.95

Dual interference G x M

Concentration M	Concentration G (µg.l^{-1})				Average M
	0	50	100	150	
0	451.25	615.12	840.49	673.28	645.00
2	689.22	912.99	1181.30	910.38	923.47
4	762.16	974.33	1199.65	931.98	967.03
LSD=0.05	223.58				63.95
Average G	634.21	834.15	1073.81	838.55	
LSD=0.05	73.85				

to untreated plants.

Estimating the yield percentage in the plant

Number of pods (pod. Plant^{-1})

(Table 5) shows a significant increase in the average number of pods, as the concentration resulted in 2 g.L^{-1} from the nanoculturated highest average of 186.36 pods. Plant^{-1}, with an increase of 44.60% compared to untreated plants. The concentration gave 4 g.l $^{-1}$ from normal fertilization, the highest average number of pods was 168.88 pods. 1 plant and an increase of 28.12% compared to untreated plants. The treatment resulted in spraying the Gibberellic acid at a concentration of 100 µg.l^{-1}, the highest average of 183.36 pods, plant^{-1}, and an increase of 40.34% compared to untreated plants. The treatment of bilateral interference showed a significant increase, as the concentration gave 2 g.l^{-1} from the nano-fertilizer and 4 g.l^{-1} from the normal fertilizer, the highest average of 208.30 pods. The results of the bilateral interaction between the nano fertilizer and the Gibberellic acid showed a significant difference, as the concentration resulted in 2 g.l^{-1} from the nano fertilizer and 100 µg. Change the transaction. The concentration gave 4 g.l^{-1} from the normal fertilizer and 100 µg.l^{-1} from the Gibberellic acid, the highest value of the interference reached 200.28 pods. Plant^{-1}. The increase was 93.58% compared to untreated plants. The triple overlap of the treatments was significant, as the treatment recorded 2 g.l^{-1} from the nano fertilizer, 2 g.l^{-1} from the normal fertilizer and 100 µg. It reached 258.66% compared to untreated plants.

Weight of seeds per pod (g. Pod^{-1})

(Table 6) shows the presence of a significant difference and positive response in the average seed weight in one pod, the concentration resulted in 2 g.l^{-1} from the nanosecond the highest value of the average seed weight in the pod amounted to 0.1749 g.Durn-1 with an increase of 35.79% compared to non-plants Transaction. The concentration gave 4 g. l $^{-1}$ from the normal fertilizer, the highest average of 0.1606 g.l^{-1} with an increase of 21.39% compared to untreated plants. The spray treatment of the Gibberellic acid showed a significant increase, as the concentration resulted in 100 µg.l^{-1}, the highest average of 0.1699 g. plant $^{-1}$, with an increase of 27.84% compared to untreated plants. The results of the bilateral interference indicated a significant superiority, as the concentration gave 2 g.l^{-1} from nano fertilizers and 2 g.l^{-1} from ordinary mineral fertilizers, the highest average value of 0.1934 g. plant^{-1}, with an increase of 71.30% compared to untreated plants. The bilateral interaction between the nano fertilizer and the Gibberellic acid was significant, The concentration gave 2 g.l^{-1} from the nano fertilizer and 100 µg.l^{-1} from the Gibberellic acid the highest value of the average weight of seeds in the pod, as it reached 0.1858 g.$^{-1}$ plant and the increase was 75.61% compared to untreated plants. The concentration showed 4 g.l^{-1} from normal fertilizer and

Table 4: The effect of nano fertilizer, normal fertilizer and Gibberellic acid and their interference on zinc content in Vegetative System (µg. kg^{-1}) for fenugreek *Trigonella foenum graecum* L.

Nano fertilizer N ($g.l^{-1}$)	Normal fertilizer M ($g.l^{-1}$)	Triple interference G x M x N GA_3 (G) ($\mu g.l^{-1}$) 0	50	100	150	Dual interference (M) x (N)
0	0	176.01	229.01	257.99	235.90	224.73
	2	239.92	265.63	281.43	242.70	257.42
	4	251.25	272.10	292.24	262.17	269.44
1	0	252.73	270.47	290.79	279.78	273.44
	2	266.26	281.20	306.75	245.92	275.03
	4	274.90	282.89	335.18	273.38	291.59
2	0	238.95	311.01	298.87	281.16	282.50
	2	271.09	314.80	408.21	307.78	325.47
	4	288.57	332.98	389.19	302.65	328.35
LSD=0.05		61.58				31.79
Dual interference G x N						
Concentration N		Concentration G (µg.l-1) 0	50	100	150	Average N
0		222.39	255.58	277.22	246.92	250.53
1		264.63	278.19	310.91	266.36	305.02
2		266.20	319.60	365.42	297.20	312.11
LSD=0.05		27.98				11.24
Dual interference G x M						
Concentration M		Concentration G ($\mu g.l^{-1}$) 0	50	100	150	Average M
0		222.56	270.16	282.55	265.61	260.22
2		259.09	287.21	332.13	265.47	285.98
4		271.57	295.99	338.87	279.40	296.46
LSD=0.05		38.08				11.24
Average G		251.08	284.45	317.85	270.16	
LSD=0.05		12.98				

100 $\mu g.l^{-1}$ Gibberellic acid above average 0.1758 $g.l^{-1}$ and an increase of 16.42% compared to untreated plants. The results of the triple interference showed a significant increase, and the concentration was given 2 $g.l^{-1}$ from the nano fertilizer and 2 $g.l^{-1}$And 100 $\mu g.l^{-1}$ of Gibberellic acid has the highest average value of 0.2017 gm^{-1}, with an increase of 203.77% compared to untreated plants.

Discussion

The results of table 1 showed that the manure has a clear effect on the studied vegetative traits, and the reason may be due to the unique characteristics of the nanofertures because of its small size, making it possible to absorb them with better efficiency than before the plant, and also increasing its surface area increased the absorption surface and its entry Directly to plant cells (Sabir *et al.*, 2014)

Also, the nano-fertilizer contains zinc, which accelerates the synthesis of tryptophan, which is the primary material for the synthesis of indole acetic acid (IAA) and in turn accelerates apical dominance, which leads to a clear increase in plant height (Mansour, 2007). It was found that fertilization by foliar spray at a rate of 0.2-0.4% of the microelements resulted in significant increases in plant height averages (Al-Hadwani, 2004). Abu Zaid (2000) mentioned that the gibberellin works to increase the division process and the breadth of the salami cells, where rapid elongation occurs after the plant is treated with the gibberellin with a significant increase in the number of cells divided in the area just below the apical meristem, and with regard to excess elongation in the cells It also leads to the withdrawal of nutrients from the leaves towards the stem, which leads to increased plant height. These results are consistent with (Abbas, 2008) in the study of the use of the gibberellins pray on the fenugreek plant in four concentrations (100, 75, 50, 25) mg.l-1, gave the concentration 100 mg.l-1 the highest average value Height of the plant. The reason is that the increase in the averages of the traits under study as a result of the intertwining of the study factors can be explained on the basis of the synergistic relationship between the concentrations of nanofertures as well as the usual fertilizers in the process of preparing the plant with abundant amounts of nutrients in order to improve the vegetative growth of the plant. Source (Abed alRahman, 2019). The physiological effect of gibberellin and its micronutrients after being sprayed on leaves on the plant explains their control of enzymatic activity and their metabolism activation, and the significant contribution to the significant transformation of nutrients to the plant growth areas (Jamal, 2007). These results are consistent with the results of (Al-Tamimi and Al-Dulaimi),which indicated that the concentration is 100 mg.l-1 interfering with the microelements (Fe, Zn, Cu, B) gave the highest value of the average height of the plant in Aloe vera. The

Table 5: Effect of Nano-Fertilizer, Regular Fertilizer, and Gibberellic acid and their Interference on the Average number of Pod. $^{-1}$ plant for fenugreek *Trigonella foenum graecum* L.

Nano fertilizer N (g.l^{-1})	Normal fertilizer M (g.l^{-1})	Triple interference G x M x N GA$_3$ (G) (µg.l^{-1}) 0	50	100	150	Dual interference (M) x (N)
0	0	70.00	112.33	140.00	118.50	110.21
	2	119.83	130.00	156.17	122.50	132.13
	4	132.33	143.83	158.67	142.34	144.29
1	0	118.00	127.16	146.67	114.68	126.63
	2	140.00	157.48	174.63	163.84	158.99
	4	154.34	154.34	200.17	171.67	170.13
2	0	122.49	164.50	180.85	166.50	158.59
	2	164.17	211.99	251.06	205.99	208.30
	4	154.70	206.67	242.00	165.52	192.22
LSD=0.05		47.34				24.45

Dual interference G x N

Concentration N	Concentration G (µg.l-1) 0	50	100	150	Average N
0	107.39	128.72	151.61	127.78	128.88
1	137.45	146.33	173.82	150.06	151.92
2	147.12	194.34	224.64	179.34	186.36
LSD=0.05	26.66				8.72

Dual interference G x M

Concentration N	Concentration G (µg.l-1) 0	50	100	150	Average N
0	103.50	134.66	155.84	133.23	131.81
2	141.33	166.49	193.95	164.11	166.47
4	147.12	168.28	200.28	159.84	168.88
LSD=0.05	34.94				8.72
Average G	130.65	156.48	183.36	152.39	
LSD=0.05	10.07				

increase in plant height is explained by the effective role of the gibberellin in increasing the elongation of plant cells and thus increasing the vegetative total of cells and then increasing the places of photosynthesis and production of nutrients, which leads to increasing the plant's content of dry matter and stimulating enzymes in order to convert complex compounds into uncomplicated compounds And using it to equip the plant with the energy needed for growth(Al-Ajeeli, 2005). As for the role of the usual fertilizer for the micronutrients, it may be due to its containment of the boron element, as it has an important role in the process of dividing and expanding the cells of the Meristamatic tissues and the developing peaks. the result of table 3 showed that the chelated iron nano-structures showed high absorption, an increase in photosynthesis and an increase in the surface area of leaves (Opik, 2005). The reason is due to the role played by micronutrients, which are represented by Fe (Zn and B), as the iron element helps in the process of forming and building chlorophyll, which in turn increases the speed of photosynthesis results, which are used in various vegetative growth processes such as elongation, cell division and increasing the leaf area (Iran, 2009). As for the treatment of the Gibberellic acid, it gave a significant superiority, as the treatment recorded 150 mg. Liters of the gibberellin had the highest concentration of 8.8597 cm2, with an increase rate of 24.45% compared to untreated plants. These results are consistent with the results of (Al-Sahaf, 1989) in a study on the pea plant. The table indicates a significant increase in treatment with spraying the Gibberellic acid, and this is explained by the fact that spraying the gibberellin on the plant preserves the chlorophyll and prevents it from degradation (Jassem and Naeem, 2013). It stimulates the growth of plants and the development of their cells and works to increase the effectiveness of photosynthesis and increase the side shoots that give branches and leaves as well as hinder the aging and fall of leaves, which leads to an increase in the number of leaves and their area until the end of the season (Devlin and Francis, 1998). The reason for increasing the foliar area when using regular fertilizers is due to the increase in the number of main branches of the plant and in turn is reflected in the increase in the number of buds in the plant and then the increase in the number of leaves, which in turn gives the increase of the foliar area of the plant (Al-Muhammadi, 2011). Nanofertilization can lead to modification of the plant's gene expression and associated biological pathways that ultimately affect plant growth and development, thereby improving the role of habitual fertilization (Alkhafaji, 2011). The reason is that the presence of the micronutrients increases the growth of the plant by improving the mechanical strength of leaves and stems and thus providing for the reception of light radiation and absorption of light and increasing the plant's ability to photosynthesis (El-Salhy, 2011).The results of table 4 indicated that this increase in the iron content

Table 6: Effect of Nano Fertilizers, Regular Fertilizers, and Gibberellic acid and their Interference on Average Weight of Seeds per Pod in Fenugreek *Trigonella foneum graecum* L.

Nano fertilizer N (g.l^{-1})	Normal fertilizer M (g.l^{-1})	Triple interference G x M x N				Dual interference (M) x (N)
		GA$_3$ (G) (μg.l^{-1})				
		0	50	100	150	
0	0	0.0664	0.1195	0.1516	0.1142	0.1129
	2	0.1213	0.1303	0.1634	0.1177	0.1332
	4	0.1298	0.1357	0.1513	0.1443	0.1403
1	0	0.1099	0.1180	0.1647	0.1395	0.1330
	2	0.1453	0.1535	0.1662	0.1559	0.1552
	4	0.1527	0.1535	0.1744	0.1604	0.1602
2	0	0.1188	0.1616	0.1586	0.1645	0.1509
	2	0.1819	0.1970	0.1970	0.1976	0.1934
	4	0.1704	0.1766	0.2017	0.1731	0.1805
LSD=0.05		0.038				0.019

Dual interference G x N

Concentration N	Concentration G (μg.l-1)				Average N
	0	50	100	150	
0	0.1058	0.1285	0.1554	0.1254	0.1288
1	0.1360	0.1417	0.1684	0.1519	0.1495
2	0.1570	0.1784	0.1858	0.1784	0.1749
LSD=0.05	0.023				0.008

Dual interference G x M

Concentration M	Concentration G (μg.l^{-1})				Average M
	0	50	100	150	
0	0.0984	0.1330	0.1583	0.1394	0.1323
2	0.1495	0.1603	0.1755	0.1571	0.1606
4	0.1510	0.1553	0.1758	0.1603	0.1606
LSD=0.05	0.028				0.008
Average G	0.1329	0.1495	0.1699	0.1519	
LSD=0.05	0.009				

when spraying the nano-fertilizer can explain that the nano-fertilizer has a role in increasing the root growth (length, size, and diameter of the roots) and thus the formation of a large root system helps to absorb large amounts of the iron element and the reason for that is due to a role Nano-fertilizer that helped increase growth Vegetative, which in turn requires the absorption of large quantities of nutrients important for the continuation of vital processes in the plant, and these results are consistent with (Raliya and Tarafdar, 2013). The role of foliar fertilization is explained by the non-nano-micronutrients (zinc, iron, and copper) that greatly affect the biological and physiological processes within the plant cells, as they are essential to the growth and development of the plant as well as increasing its resistance to many diseases and interfering with the synthesis of enzymes or auxiliary factors in interactions. Vitality and its presence positively affects the improvement of plant growth and increase the absorption of nutrients from the roots, increasing its concentration within the plant and thus increasing the plant's quantity and quality (Al-Maliki, 2018). The root cause an increase in the surface area of the roots (Al-Nuaimi, 2000), And thus increase the absorption of micronutrients by the plant and its accumulation in the plant, which leads to an increase in vegetative growth, which is reflected in the increase in dry weight and the resultant increase in the iron content. These results are consistent with the findings of (Ibrahim, 2019), who indicated that the use of metallic and nucleic boron in an overlapping manner gave the highest value of the average iron concentration in the livestock compared to other treatments. The reason for the increase in iron in the dry matter of the plant is due to the increase in the concentration of added iron in the spray solution for nanostructures and regular non-nano fertilizers because the plants did not get enough of the iron present in the soil, as well as the role of the gibberellin in increasing the root growth, which helps absorb large amounts of iron. And its accumulation inside the plant (Al-Zaini, 2013), (Al-Dulaimi and Al-Darraji, 2014) and (Adel,2010) .The results of table 4 showed that there was a significant increase in the zinc content in the vegetative group of fenugreek, where the treatment of adding nano fertilizer recorded a significant difference. These results are consistent with what was reached by him (Al-juthery and Saadoun, 2019) when using foliar spray of nanofertilizers of the microelements on The Jerusalem Artichoke Goat plant recorded the highest value of the average zinc content. The reason can explain the role of micronutrients in the formation of amino acids, carbohydrates and energy compounds, and then support the increased breathing and photosynthesis processes that lead to growth. Vegetative and root helps to absorb large quantities of nutrients in addition to the additive through foliar spray, which leads to a high concentration of zinc in the leaves (Zain *et al.*, 2015) And the treatment of the addition of the usual fertilizer gave a significant difference, which explains that the balanced addition of the elements supplied to the plant through foliar spray has improved the growth of the plant and helped to increase its ability to absorb micronutrients, including zinc, which is important to the plant, in addition to increasing its concentration in the nutrient solution(Farhan and Al-Muaini, 2013) . The result of spraying the gibberellin showed a significant difference, and these results are consistent with what it reached (Yassin, 2014), where three concentrations of the gibberellin (0, 50,100) mg.l-1 used is the highest average value compared to untreated plants. The reason for the increase of the zinc element in the leaves when using two types of nutrient fertilizer (nanoscale and regular) is due to the need of the plant for more elemental zinc that is physiologically important for the growth and development of the plant because the plant did not get its zinc need from the soil and this is what causes the plant treated with leaf spray to absorb greater As much zinc as possible (Jassim and Al Jumaili, 2013). In spite of the availability of this element in the soil, the ready of it is not sufficient to meet the needs of the plant from it, especially the plants of the family and legumes, including the fenugreek plants, zinc plays an important and effective role in protein formation and activity and protection of the fenugreek plant from the damages resulting from oxygen reactions and the representation of carbohydrates (Mousavi and Rezaei, 2011) Zinc deficiency leads to a clear decrease in photosynthesis and nucleic acid destruction activities and a decrease in the amount of carbohydrate and protein synthesis (Mousavi et al,*et al*., 2007). Here, the need to use more than one fertilized type with different concentrations is needed in order to provide sufficient quantities appropriate to the need Plants b Anecdotal of this component. This can be explained by the fact that the gibberellin plays a regulatory role in the effectiveness of the enzymes that control the metabolism of carbohydrates, which leads to increased plant growth in general, as the gibberellin has a long-term effect on plant growth, which leads to an increase in the number of pods (Abu Dahi and Al-Younis,1988). The reason for increased production is due to excellence Nanoscale fertilizers have unique properties due to their small size and its large surface area that leads to an increase in the absorption surface and thus an increase in photosynthesis and thus an increase in plant production (Singh, 2016), The increase in the characteristics of the seed weight, especially at concentration 4 g. l^{-1}, is attributed to the role of mineral micronutrients, especially the copper element in photosynthesis, through its role in increasing growth, which leads to an increase in nutrients made by leaves and their transfer to fruits, which leads to an increase Weighing and increasing the abundance of the quotient. These results are consistent with the findings of (Al-Saadi and Al-Shammari, 2013), who indicated that spraying the fenugreek plant with the gibberellin gave a significant difference in the percentage of dysogenin, where the treatment recorded 100 mg. l^{-1} the highest rate of diosgenin concentration. The use of the gibberellins encouraging for the germination process and the growth and development of the plant, because increasing its concentration stimulates the division and elongation of cells in the apical meristem, and the apical end of the feathering, or by activating some cell chromosome genes that lead to the activation of the formation of DNA, which in turn depends on the formation of m-RNA and then the formation of enzymes Hydrolysis and chemical compounds important for the growth and expansion of the plant cell (Al-Hadwani, 2000)

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