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THE EFFECT OF ORGANIC AND BIO FERTILIZATION AND SPRAYING WITH SOME NANO ELEMENT ON THE YIELD TRAITS AND COMPONENTS OF THE FENUGREEK PLANT (*TRIGONELLA FOENUM-GRAECUM* L.)

Nabhan Awad Mohammd Khalaf and Aqeel Najm Abboud Al-Mohammadi
College of Agriculture, Tikrit University, Department of Field Crops, Iraq

Abstract

A field study was conducted at the research station of the Department of Field Crops belonging to the College of Agriculture - Tikrit University, during the two winter seasons of the years (2018-2019) and (2019-2020), using the randomized complete block design (RCBD) according to a factorial experiment system within the split plots (Factorial in split-plots), and in three replicates. The main plot included the spraying levels with nano-elements (whitout adding, Nano iron 160 mg.L^{-1}, Nano cobalt 3 mg.L^{-1}, Nano iron 160 mg.L^{-1} + Nano cobalt 3 mg.L^{-1}), As for the sub-plots, the resulting combinations were distributed between the levels of bacterial inoculation of *Sinorhizobium meliloti* seeds (inoculation , without inoculation) and organic fertilization with sheep manure (0, 2, 4, 6) tons.dunum^{-1}. The second season, and its interaction with the study's factors and combinations, also excelled significantly in their impact by giving it the highest averages in the yield and its components compared to the first season. As for the interaction between the factors of the study, the triple combination between (iron 160 mg.L^{-1} + cobalt 3 mg.L^{-1}), bacterial inoculum and organic fertilization at an average of (6) tons. dunum^{-1} recorded a highly significantly excelled in the traits of the yield and its components. Through the results that have been reached, we find that the foliar spraying with the chelated nano-elements of iron and cobalt together and the inoculation of seeds with rhizobia with the addition of decomposed organic sheep manure can create a kind of natural balance in the nutritional status of the fenugreek plant, which positively affects the improvement of the quantity and quality of the yield and its components for the plant.

Key words: fenugreek, nanofertilization, bacterial inoculum (S.meliloti), organic fertilization, yield and its components

Introduction

Medicinal plants have been considered since ancient times and to this day a repository of knowledge evidence for modern drugs and a source of successful drugs, because these plants produce various chemical compounds through their secondary metabolism, which are used to improve the composition and manufacture of drugs or as a source of effective drugs with low cost, in addition to some of them. An important source of nutrition, where it has been used in the treatment of various pathologies (Hassan, 2012) and fenugreek. Trigonella foenum-graecum L, which belongs to the plants of the Fabaceae family, is one of the most important of these plants, which has great biological and medicinal properties and is important because it contains active compounds such as caraine alkaloids, choline, Trigonelline, gentianine and soaps (Gitogenin, Yamogenin, Diosgenin, Neotigogenin, Tigogenin) and flavonoids. (apigenin, Luteoline, Quercetin, as well as glycosides and mucilage),Therefore, it has been used to reduce the abnormal level of sugar and cholesterol in the blood, treat infections and cancer, as an immune booster and a source of steroid sex hormones, in adding to being a source of proteins, carbohydrates and vitamins, the most important of which are (C, B1, A), oils of both volatile and stable types, and mineral elements such as iron, calcium and phosphorous (Nagananda et al, 2010, Snehlata and Pyal, 2012 (Moradi Kor et al., 2013),It could also be used in the production and development of food in the field of food stabilizer, adhesive and emulsifiers, and most importantly the development of healthy foods (Wani and Kumar, 2018). The crop capacity, or what is known as the yield in addition to the biological yield, affects when the fenugreek plant is grown under the conditions of using modern production technology, through the improvement and integration of the physiological interactions in the plant, so that any factor that affects the physiological activity and during any stage of plant growth can affect Positive yield(Ahmed et al. 2010) and one of the most important of these techniques is the smart use of nutrients according to nanotechnology, because nano fertilizers exhibit traits and features that differ from them when their composition is in their traditional dimensions, so they are considered one of the reliable sources of the elements necessary for plant growth. This is due to its high absorption capacity by the plant, its high stability after use, the non-entry of ethylene in its composition, and the increase of their percentage on the claw surface and has a high absorption surface, which has an important role in raising the efficiency of photosynthesis processes and thus increasing the average of growth and yield in the plant (Singh and Prasad, 2017 and Singh, 2017). It was also found that the use of bio fertilizers, especially the bacterial vaccine that belongs to the Rhizobia group, is an important or complementary alternative to the use of chemical fertilizers in providing the plant needs of the elements necessary for growth, especially nitrogen. These fertilizers are added either to the soil or the seeds are treated with it and thus improve plant growth and yield, as it is a good and important source of fertilization in agricultural fields in addition to being environmentally friendly agricultural materials (Soundari et al., 2015 ; Zaghloul et al., 2011 and Gayrley et al., 2015) stated that adding organic waste to the soil improves its structure, increases its ability to retain water, and improves its biological activity and increasing the cationic exchange capacity of the soil and thus making the elements easier for absorption by the plant, in addition to enriching its content of organic matter and elements (C, N, P, K,) and (CO_2) gas that the plants need, as it is an important step to achieve sustainable agriculture. In improving plant growth and increasing yield. Given the medical, biological, and nutrition importance of the fenugreek plant on the one hand, and the lack of research and studies investigating the effect of nanostructured fertilizers, especially foliar spraying with iron and cobalt nano elements, and the use of bio fertilizers and organic residues on the growth and yield of the fenugreek plant on the other hand, In addition to finding good fertilizer combinations that improve the growth conditions and yield of fenugreek better, which are characterized by the lowest costs and the safest for the agricultural environment and human health, this research was conducted.

Materials and Methods

The study was conducted in fields belonging to the research station of the Field Crops Department - College of Agriculture - Tikrit University, which is located in the northern side of Tikrit district, center of Salah al-Din province - Republic of Iraq, during the two winter seasons

(2018-2019) and (2019-2020),In a gypsum soil, its physical, chemical and biological properties have been determined after conducting the laboratory analysis, and the details of which are shown in Table (1)

Table (1): some of the physical, chemical and bio traits of the soil before cultivation .

Units	Values		Traits	No
	2020-2019	2019-2018		
/	7.52	7.63	pH	-1
$Ds.m^{-1}$	2.68	2.49	Electrical conductivity (Ec(	-2
Centimole kg^{-1} soil	13.37	13.23	Cation Exchange Capacity (CEC)	-3
$g.cm^{3}$	1.55	1.37	Bulk Density (B.D)	-4
$g.kg^{-1}$ soil	4.39	2.77	Organic Matter (O.M)	-5
	32.25	38.00	gypsum	-6
$mg . kg^{-1}$ soil	22.41	17.38	Availability nitrogen (N)	-7
	6.47	5.66	Availability phosphorous (P)	-8
	110.16	90.24	Availability Potassium (K)	-9
$Mmol. L^{-1}$	12.11	10.21	Sulfate (SO4 =)	10-
	9.7	7.27	Calcium (Ca++)	11-
	1.15	1.33	Sodium (Na +)	12-
	4.59	5.53	Chloride (CI-)	13-
$g. kg^{-1}$	666		the sand	14-
	76		Silt	15-

	258				Clay	16-
	sandy Loam				soil texture	17-
	after sterilization	Before sterilization	after sterilization	Before sterilization	Macroorganism numbers	18-
CFU g-1 soil	$10^3 \times 0.38$	$10^3 \times 5.11$	$10^3 \times 0.42$	$10^3 \times 4.23$	Total numbers of fungi	
	$10^4 \times 0.39$	$10^4 \times 2.67$	$10^4 \times 0.84$	$10^4 \times 7.12$	Total bacterial numbers	
	$10^4 \times 0.58$	$10^4 \times 4.15$	$10^4 \times 0.91$	$10^4 \times 1.11$	Numbers of Rhizobium ssp	

Service operations were conducted for the field soil from tillage and smoothing with disc plow two perpendicular plows, after which the field was divided by demarcating the boundaries of (96) experimental units with dimensions (2x2 m) while leaving a distance between the experiment units (0.5 m) and between the sectors (1 m) according to the Randomized Complete Block Design (RCBD) using the factor method within split-plot, After that, drip irrigation tubes were extended along the cultivation lines, after that the solar sterilization process of the soil was conducted by covering the experiment units tightly with transparent polyethylene material, with the irrigation process being conducted during every 10 days after each irrigation, and after (60) days the polyethylene cover was removed. Simple tillage of the soil was conducted and left for two days for aeration, with the addition of fertilizing at once on all experiment units of superphosphate fertilizer (30 kg.dunum^{-1}) and nitrogen in the form of urea (46%) at an average of (10 kg. Dunum-1). Use a quarter of the amount and Potassium (25 kg. dunum^{-1}) (Al-Hidwani, 2004),The inoculation and without inoculation seeds were planted on 11/4 of each season, and the locations of infertility were determined by means of a ruler containing the dimensions of the distance between the lines (30 cm) and the pit (25 cm). Where the foliar spraying treatments were counted as the main factor and in four levels (without spray, iron 160 mg. L^{-1}, cobalt 3 mg. L^{-1}, (iron 160 + cobalt 3) mg. L^{-1}, which was sprayed in stage 4 -6 leaves of plant growth .the secondary factor included combinations between the levels of bio fertilizer with Rhizobia of the type ((Sinorhizobium meliloti) (inoculation, without inoculation) and the organic fertilization with decomposing sheep manure ((without adding, 2, 4, 6) tons. dunum^{-1}), which was added. When preparing the soil.The studied traits: After the plants reached full maturity, five plants were taken from the midlines, randomly to the experiment units, and the following traits were measured:

1- Average number of pods (pod. Plant $^{-1}$): The number of pods for the five plant was calculated and the average for one plant was calculated.

2- The average number of seeds per pod (seed. pod $^{-1}$). The number of seeds per pods for the five plant was counted and divided by the number of pods.

3- Weight of 1000 seeds (g): The weight of a thousand seeds of the total seeds belonging to each experiment unit.

4- Total biological yield (kg. ha^{-1}): the weight of all plant parts at the stage of full maturity, with the exception of the root system, from an area of (1 sq. 48 hours, after stabilizing the weight, the total biological yield (kg.ha^{-1}) was estimated by using the equation below:

Total biological yield (kg. ha^{-1}) = biological yield m^2 x 10,000

5- Total seed yield (kg. ha^{-1}): It was calculated from the weight of the seeds produced from each experiment unit, and it was estimated in kg. ha^{-1} according to the equation below:

The amount of yield per hectare$=\frac{\textit{Amount of yeild in the experiment unit (kg)}}{\textit{Area of the experimental unit } (m2)}\times 10000$

6- Harvest index (%): It is considered one of the indicators that show the efficiency of plants in the distribution of metabolites between economic yield and biological yield, and it is estimated using the following equation: -

Harvest index$=\frac{\textit{The seed yield } kg.ha-1}{\textit{Biological yield } kg.ha-1}\times \mathbf{100}$

After collecting the data, the averages of the traits for the two seasons were analyzed using the (SAS) program according to the meta-analysis method and the averages of the studied traits were compared with the method of (Duncan) test of multiple range and at the level (5%) (Al-Rawi and Khalaf Allah, 2000).

Results and Discussion:

Average number of pods (pod. Plant $^{-1}$)

The results in Table (2 - a, b) indicated that there was a significant difference in the average number of pods per plant due to their influence by study factors and their bi and triple interactions. Individual treatments were recorded when nano fertilizing at the level (iron 160 + cobalt 3) mg.L^{-1}, the addition of decomposing organic waste at an average of (6 tons.$dunum^{-1}$) and inoculation of seeds with Rhizobia of the type (*S. meliloti*). The highest averages in the number of pods were (49.95), (53.98) and (58.01)pod.$plant^{-1}$, respectively, compared with non-fertilized treatments, which gave the lowest average number of pods per plant. Also, the bi-interaction between the two treatments of fertilization with nanoparticles and at the level (iron 160 + cobalt 3) mg. L $^{-1}$ with seed inoculation with bacteria (*S. meliloti*) and the combination between the level (iron 160 + cobalt 3) mg. L $^{-1}$ with addition the organic decomposition waste at an average of (6 tons.$dunum^{-1}$) and the combination of inoculation the seeds with (*S.meliloti*) with the addition of the organic decomposing waste at an average of (6 tons.$dunum^{-1}$) gave the highest average for pods of (63.23) and (58.34) and (66.61) pod. Plant $^{-1}$ respectively compared to the non-fertilized treatments. As for the effect of triple interaction, the interaction treatment was achieved between nano fertilization with macro elements at the level (iron 160 + cobalt 3) mg.L^{-1} with S. meliloti seed inoculation and the addition of decomposing organic waste at an average of (6 tons. $dunum^{-1}$). On all treatments and their interaction, by giving them the highest average number of pods per plant, which reached (73.60) pods.$plant^{-1}$ compared to the non-fertilized treatment, which gave the lowest average number of pods of (21.57) pods. $Plant^{-1}$.With regard to the effect of the seasons and their combinations with the study factors and their interactions, all of them were significant in the number of pods. The treatment of the second season gave a significant advantage in their effect on increasing the average number of pods, which reached (52.43) pods. Plant^{-1} compared to the first season, which recorded the lowest number of pods (40.06) pods. Plant^{-1}, as for the overlap between the treatments and their combinations with the seasons. The fertilization with nano microelements at the level of (iron 160 + cobalt 3) mg.L^{-1} and inoculation with Rhizobia type (S.meliloti) and the addition of decomposing organic waste at an average of (6 tons.dunum^{-1}) alone, and the bi-interaction between (iron 160 + cobalt 3) mg. L^{-1} × Rhizobia inoculation type (S. meliloti) and between treatment (iron 160 + cobalt 3) mg. L $^{-1}$ × decomposed organic waste at an average of (6 tons.dunum $^{-1}$) and (inoculation with S. meliloti type rhizobia × decomposed organic waste at an average of (6 tons.dunum^{-1}) and the triple combination between (iron 160 + cobalt 3) mg.L^{-1} and inoculation with the type (S. meliloti) and the addition of dissolved organic waste at an average of (6 tons.dunum^{-1}) in the second season, the highest average number of pods reached (57.05) and (66.19, (62.04), (72.68), (66.41), (76.67), and (83.53) pods.Plant^{-1} respectively for treatments , while the lowest averages for the trait were recorded for the non-fertilized treatment in the first season.

Table (2-a) Effect of organic and biofertilization and spraying with some nano-elements and seasons and their combinations on the average number of pods (pod. plant^{-1}) of fenugreek plant.

Average fertilization effect			seasons		Fertilization treatments and levels	
organic	**Bio**	**Nano**	**second**	**first**		
		41.17 d	45.90 d	36.44 h	0	Nano Fertilization mg.L^{-1}
		47.74 b	54.56 b	40.91 f	Fe (160)	
		46.13 c	52.21 c	40.05 g	Co (3)	
		49.95 a	57.05 a	42.84 e	Fe160+Co 3	
	34.49 b		38.68 c	30.29 d	بدون تلقيح	Bio fertilization
	58.01 a		66.19 a	49.83 b	تلقيح	
38.81 d			42.79 g	34.82 h	0	organic fertilization tons. dunums $^{-1}$
43.63 c			49.10 c	38.15 e	2	
48.58 b			55.80 b	41.35 f	4	
53.98 a			62.04 a	45.92 d	6	
Average effect of interaction between nano and bio fertilizer			**Second season**	**first season**	**Bio fertilization**	**Nano Fertilization mg.L^{-1}**
32.02 h			35.61 k	28.42 n	without inoculation	0
35.32 f			39.80 i	30.84 m		Fe (160)
33.95 g			37.88 j	30.02 m		Co (3)

36.67 e	41.43 h	31.90 l		Fe (160) + Co(3)
50.34 d	56.20 de	44.47 g	inoculation	0
60.16 b	69.33 b	50.99 f		Fe (160)
58.31 c	66.53 c	50.09 f		Co (3)
63.23 a	72.68 a	53.77 e		Fe (160) + Co(3)
Average effect of interaction between nano and organic fertilizers	**Second season**	**first season**	**organic fertilization tons. dunums $^{-1}$**	**Nano Fertilization mg.L^{-1}**
33.15 l	36.40 rq	29.90 s	0	0
39.36 k	43.17 jk	35.54 r	2	
42.55 i	46.90 i	38.20 p	4	
49.65 d e	57.15 de	42.14 mn	6	
40.80 j	45.02 ml	36.57 qr	0	Fe 160 mg.L^{-1}
45.14 g	51.20 g	39.07 o	2	
50.30 d	58.63 d	41.97 mn	4	
54.72 b	63.40 b	46.04 ij	6	
38.91 k	42.45 lmn	35.37 r	0	Co 3 mg.L^{-1}
43.77 h	49.27 h	38.27 op	2	
48.63 e	55.92 e	41.34 n	4	
53.22 c	61.20 c	45.24 jk	6	
42.37 i	47.29 i	37.44 pq	0	Fe (160) + Co (3) mg.L^{-1}
46.25 f	52.76 f	39.74 o	2	
52.83 c	61.76 c	43.90 kl	4	
58.34 a	66.41 a	50.27 gh	6	

Continued Table No. (2- b)

The average effect of the interaction between the bio-organic fertilizer	Second season	first season	organic fertilization tons. dunums $^{-1}$	Bio fertilization
26.74 h	28.83 k	24.65 l	0	without inoculation
32.65 g	36.22 i	29.07 k	2	
37.21 f	42.26 h	32.15 j	4	
41.36 e	47.41 f	35.30 i	6	
50.87 d	56.75 d	44.99 g	0	inoculation
54.61 c	61.98 c	47.24 f	2	

59.95 b	**69.35 b**	**50.55 e**	**4**		
66.61 a	**76.67 a**	**56.54 d**	**6**		
Average effect of interaction between nano, bio, and organic fertilization	**Second season**	**first season**	**organic fertilization tons. dunums $^{-1}$**	**fertilization**	
				Bio	**Nano**
21.57 C	**23.00 O**	**20.13 N**	**0**	**without inoculation**	**0**
30.87 yz	**33.47 D-G**	**28.27 JKL**	**2**		
35.60 uv	**40.13 yz**	**31.07 GHI**	**4**		
40.02 qr	**45.83 tuv**	**34.20 DEF**	**6**		
44.74 n	**49.80 o-r**	**39.67 yz**	**0**	**inoculation**	
47.84 m	**52.87 lmn**	**42.80 wx**	**2**		
49.50 l	**53.67 klm**	**45.33 uv**	**4**		
59.27 ef	**68.47 de**	**50.07 opq**	**6**		
28.72 A	**31.10 GHI**	**26.33 ML**	**0**	**without inoculation**	**Fe 160 mg.L^{-1}**
33.29 wx	**37.30 AB**	**29.27 IJK**	**2**		
37.64 st	**43.00 wx**	**32.27 G**	**4**		
41.64 op	**47.80 q-t**	**35.47 BCD**	**6**		
52.87 j	**58.93 i**	**46.80 stuv**	**0**	**inoculation**	
56.99 gh	**65.10 fg**	**48.87 p-s**	**2**		
62.97 d	**74.27 c**	**51.67 mno**	**4**		
67.80 b	**79.00 b**	**56.60 j**	**6**		
26.50 B	**28.27 IJK**	**24.73 MN**	**0**	**without inoculation**	**Co 3 mg.L^{-1}**
31.97 xy	**35.07 B-E**	**28.87 IJK**	**2**		
36.64 tu	**41.47 xy**	**31.80 GH**	**4**		
40.70 pq	**46.73 s-v**	**34.67 CDE**	**6**		
51.32 k	**56.63 j**	**46.00 tuv**	**0**	**inoculation**	
55.57 hi	**63.47 gh**	**47.67 q-u**	**2**		
60.62 e	**70.37 d**	**50.87 nop**	**4**		
65.74 c	**75.67 c**	**55.80 jk**	**6**		
30.17 zA	**32.93 EFG**	**27.40 KL**	**0**	**without inoculation**	**160) (3 + Fe + Co mg.L^{-1}**
34.46 vw	**39.05 zA**	**29.87 HIJ**	**2**		
38.95 rs	**44.43 w**	**33.47 E-G**	**4**		
43.08 o	**49.28 pqr**	**36.87 ABC**	**6**		
54.56 i	**61.65 h**	**47.47 r-u**	**0**	**inoculation**	
58.04 fg	**66.47 ef**	**49.60 o-r**	**2**		
66.71 bc	**79.08 b**	**54.33 kl**	**4**		
73.60 a	**83.53 a**	**63.67 gh**	**6**		
40.06 b			**first**	**Seasons effect**	

52.43 a	**Second**	

Average number of seeds per pod (seed. pod^{-1}):

The results appearing in Table (3-a, b) indicate that there is a significant difference in the average number of seeds per pod per plant as a result of being affected by study factors and their bi and triple interaction. The individual treatments were recorded when fertilizing with nanoparticles and at the level (iron 160 + cobalt 3) mg.L^{-1}, adding decomposed organic waste at an average of (6 tons.dunum^{-1}) and inoculating seeds with Rhizobia of the type (*S. meliloti*) the highest averages in the number of The seeds were 16.42, 16.25 and 16.11 seeds. pod^{-1}, respectively, compared with the non-fertilized treatments that gave the lowest average number of seeds per pod.Also, the bi-interaction between the two treatments of fertilization with nanoparticles and at the level (iron 160 + cobalt 3) mg. L $^{-1}$ with seed inoculation with bacteria (S. meliloti) and the combination between the level (iron 160 + cobalt 3) mg. L^{-1} with addition The organic decomposition waste at an average of (6 tons. dunum^{-1}) and the combination between inoculation the seeds with (S.meliloti) with the addition of the organic decomposing waste at an average of (6 tons.dunum^{-1}).It gave the highest average of (17.01), (16.93) and (16.63) seeds.pod^{-1} respectively compared to the unfertilized treatments.As for the effect of triple interaction, the interaction treatment between fertilization with nano macro elements at the level (iron 160 + cobalt 3) mg.L $^{-1}$ with S. meliloti seeds inoculated with the addition of decomposing organic wastes at an average of (6 tons. Dunum-1)on all treatments and their interactions, by giving them the highest number of pods in the plant, which amounted to (17.56) seeds. pod $^{-1}$ compared with the non-fertilized treatment which gave the lowest average in the number of seeds amounted to (13.18) seeds. pod $^{-1}$. With regard to the effect of seasons and their combinations with the study factors and their interactions, all of them had a significant effect on the number of pods. The treatments of the second season gave a significant superiority in their effect in increasing the average number of pods, which amounted to (15.44) seed.pod^{-1} compared with the first season, which recorded the lowest number of seeds. (15.12) seed.pod^{-1},As for the interaction between the treatments and their combinations with the seasons, fertilization with nano macro elements and at the level (iron 160 + cobalt 3) mg. L^{-1} and the inoculation with Rhizobia type (S. meliloti) and the addition of decomposing organic waste at an average of (6 tons. dunum^{-1}) and the bi-interaction between (iron 160 + cobalt 3) mg. L^{-1} × rhizobia inoculation (S. meliloti) and between (iron 160 + cobalt 3) mg. L^{-1} × decomposed organic waste at an average of (6 tons. dunum$^{- 1}$) and (S. at an average of (6 tons. dunum^{-1}) in the second season, the highest average number of seeds reached (17.56), (16.56), (16.47), (17.84), (17.79), (16.80) and (18.22) seeds.pod^{-1}. In respectively, the lowest averages for the trait were recorded in the treatment not fertilized in the first season.

Table (3-a) The effect of organic and biological fertilization and spraying with some nano and the seasons and their combinations on the average number of seeds per pod (seed. Pod $^{-1}$) of the fenugreek plant.

Average fertilization effect			seasons		Fertilization treatments and levels	
organic	Bio	Nano	second	first		
		14.75 d	14.80 g	14.70 h	0	Nano Fertilization mg.L^{-1}
		15.57 c	15.98 c	15.15 e	Fe (160)	
		15.87 b	16.73 b	15.00 f	Co (3)	
		16.42 a	17.56 a	15.27 d	Fe160+Co 3	
	15.05 b		15.95 b	14.15 d	without inoculation	Bio fertilization
	16.25 a		16.58 a	15.91 c	inoculation	
15.22 d			16.06 c	14.37 g	0	organic fertilization tons. dunums $^{-1}$
15.54 c			16.24 b	14.83 f	2	
15.74 b			16.30 b	15.18 e	4	
16.11 a			16.47 a	15.74 d	6	
Average effect of interaction between nano and bio fertilizer			Second season	first season	Bio fertilization	Nano Fertilization mg.L^{-1}
14.06 h			14.24 k	13.88 m	without inoculation	0
15.03 g			15.79 g	14.26 jk		Fe (160)
15.29 f			16.50 d	14.08 l		Co (3)
15.83 d			17.28 b	14.37 j		Fe (160) + Co(3)
15.44 e			15.35 i	15.52 h	inoculation	0
16.11 c			16.17 e	16.04 f		Fe (160)
16.45 b			16.97 c	15.93 f		Co (3)
17.01 a			17.84 a	16.17 e		Fe (160) + Co(3)
Average effect of interaction between nano and organic fertilizers			Second season	first season	organic fertilization tons. dunums $^{-1}$	Nano Fertilization mg.L^{-1}
14.24 i			14.47 pq	14.00 r	0	0
14.76 h			14.92 lmn	14.59 p	2	
14.80 h			14.76 no	14.84 mn	4	
15.21 d			15.04 kl	15.38 i	6	

15.20 g	15.85 hg	14.54 p	0	Fe 160 mg.L^{-1}
15.44 f	15.92 fg	14.95 lm	2	
15.65 e	16.02 ef	15.28 ij	4	
15.99 d	16.14 e	15.84 gh	6	
15.46 f	16.60 d	14.32 q	0	Co 3 mg.L^{-1}
15.76 e	16.68 d	14.83 mn	2	
15.97 d	16.76 cd	15.18 jk	4	
16.30 c	16.90 c	15.69 h	6	
15.99 d	17.34 b	14.63 po	0	Fe (160) + Co (3) mg.L^{-1}
16.21 c	17.44 b	14.98 lm	2	
16.54 b	17.66 a	15.41 i	4	
16.93 a	17.79 a	16.06 ef	6	

Continued Table No. (2- b)

The average effect of the interaction between the bio-organic fertilizer	Second season	first season	organic fertilization tons. dunums $^{-1}$	Bio fertilization	
14.48 h	15.73 f	13.23 k	0	without inoculation	
14.96 g	15.96 e	13.95 g	2		
15.20f	15.98 e	14.41 i	4		
15.58 e	16.13 d	15.02 h	6		
15.96 d	16.40 c	15.51 g	0	inoculation	
16.12 c	16.51 bc	15.72 f	2		
16.29 b	16.62 b	15.95 e	4		
16.63 a	16.80 a	16.46 c	6		
Average effect of interaction between nano, bio, and organic fertilization	Second season	first season	organic fertilization tons. dunums $^{-1}$	fertilization	
				Bio	Nano
13.18 s	13.65 IJK	12.70 M	0	without inoculation	0
14.15 r	14.48 DE	13.81 HIJ	2		
14.27 r	14.27 EF	14.26 EF	4		
14.66 pq	14.56 CD	14.76 BC	6		
15.30 mn	15.29 xyz	15.30 xyz	0	inoculation	
15.36 lm	15.36 xyz	15.36 xyz	2		
15.33 m	15.25 xyz	15.41 wxy	4		
15.75 ij	15.51 u-x	15.99 m-q	6		
14.55 q	15.66 s-w	13.43 K	0		

14.88 o	15.73 r-v	14.03 FGH	2	without inoculation	Fe 160 mg.L^{-1}
15.15 n	15.84 p-t	14.46 DE	4		
15.53 kl	15.93 n-r	15.13 zA	6		
15.84 h	16.03 m-p	15.64 t-w	0	inoculation	
15.99 g	16.11 m-o	15.86 o-s	2		
16.15 g	16.19 k-n	16.10 m-p	4		
16.45 def	16.35 jkl	16.54 ij	6		
14.75 op	16.35 jkl	13.15 L	0	without inoculation	Co 3 mg.L^{-1}
15.16 n	16.43 jk	13.89 GHI	2		
15.43 lm	16.53 ij	14.33 DE	4		
15.82 hi	16.69 hi	14.94 AB	6		
16.17 g	16.85 gh	15.49 v-y	0	inoculation	
16.34 ef	16.92 fgh	15.76 q-u	2		
16.51 de	16.99 efg	16.02 m-q	4		
16.77 c	17.11 def	16.43 jk	6		
15.44 lm	17.25 cd	13.63 JK	0	without inoculation	160) (3 + Fe + Co mg.L^{-1}
15.64 jk	17.21 cde	14.06 FG	2		
15.93 hi	17.29 cd	14.57 CD	4		
16.29 fg	17.35 cd	15.23 yz	6		
16.53 d	17.43 cb	15.62 t-w	0	inoculation	
16.78 c	17.66 b	15.90 o-s	2		
17.14 b	18.03 a	16.25 klm	4		
17.56 a	18.22 a	16.89 fgh	6		
15.12 b			first	Seasons effect	
15.44 a			Second		

The 1000 Seeds Weight (g):

The results appearing in Table (4- a, b) indicate that there is a significant difference in the average weight of a 1000 seeds as a result of its influence by study factors and their bi and triple interaction .The individual treatments were recorded when nano fertilizing at the level (iron 160 + cobalt 3) mg. L^{-1}, adding decomposing organic waste at an average of (6 tons. dunum^{-1}) and inoculating seeds with rhizobia of the type (S. meliloti), the highest average weight 1000 seeds amounted to 15.54, 16.06 and 16.04 g, respectively, compared with non-fertilized treatments that gave the lowest average number of seeds per pod. Also, the bi- interaction between the two treatments of nano fertilization at the level (iron 160 + cobalt 3) mg. L $^{-1}$ with seed inoculation with bacteria (S. meliloti) and the combination between the level (iron 160 + cobalt 3) mg. L $^{-1}$ with the addition the organic decomposition waste at an average of (6 tons. dunum^{-1}) and the combination of inoculation the seeds with (S.meliloti) with the addition of the organic decomposing waste at an average of (6 tons. Dunum-1) gave the highest average of (16.44), (16.43) and (17.08) g.thousand seeds^{-1} respectively compared to the non-fertilized treatments.As for the effect of triple interaction, the interaction treatment fertilization with nano macroelements at the level (iron 160 + cobalt 3) mg.L^{-1} with *S. meliloti* seed inoculation and the addition of decomposing organic waste at an average of (6 tons. dunum^{-1}).excelled on all treatments and their interactions, by giving them the highest number of pods in the plant, which amounted to (17.77) g, compared with the non-fertilized treatment, which gave the lowest average in the weight of a 1000 seeds of (13.72) g, With regard to the effect of the seasons and their combinations with the study factors and their interactions, all of them were significant in the number of pods. The second season treatments gave a significant excelled in their effect in increasing the average weight of a thousand seeds, reaching (15.44) g compared to the first season, which recorded the lowest in the weight of a thousand. Seed reached (15.12) g, As for the interaction between treatments and their combinations with the seasons, fertilization with nano microelements at the level of (iron 160 + cobalt 3) mg.L^{-1} and inoculation with rhizobia type (S.meliloti) and the addition of decomposing organic waste at a rate of (6 tons.dunum^{-1}) was achieved, the bi-interaction between (Fe 160 + Cobalt 3) mg.L^{-1} × S. meliloti inoculation and (Fe 160 + Cobalt 3) mg.L^{-1} × decomposing organic residues at an average of (6 tons. dunam^{-1} and *S. meliloti* inoculation with rhizobia × *S. meliloti* inoculation) and the triple combination between (iron 160 + cobalt 3) mg. L^{-1} and inoculation with the type (S. meliloti) and the addition of organic decomposed waste at an average of (6 tons.dunum^{-1}) in the second season, the highest average weight of a thousand seeds reached (15.69) and (16.23), (16.20), (16.59), (16.57), (17.19) and (17.84) g for the treatments sequentially, while the lowest averages for the trait were recorded in the unfertilized treatment in the first season.

Table (4-a) The effect of organic and bio fertilization and spraying with some nano and seasons and their combinations on the average weight of a thousand grains (g) of the fenugreek plant.

Average fertilization effect			seasons		Fertilization treatments and levels	
organic	**Bio**	**Nano**	**second**	**first**		
		14.91 d	**15.10 e**	**14.72 f**	**0**	**Nano Fertilization mg.L^{-1}**
		15.41 b	**15.58 b**	**15.24 d**	**Fe (160)**	
		15.28 c	**15.41 c**	**15.14 e**	**Co (3)**	
		15.54 a	**15.69 a**	**15.38 c**	**Fe160+Co 3**	
	14.52 b		**14.66 c**	**14.37 d**	**without inoculation**	**Bio fertilization**
	16.06 a		**16.23 a**	**15.88 b**	**inoculation**	
14.68 d			**14.79 f**	**14.57 g**	**0**	**organic fertilization**
15.01 c			**15.13 d**	**14.89 e**	**2**	
15.42 b			**15.66 c**	**15.17 d**	**4**	

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16.04 a			16.20 a	15.87 b	6	tons. dunums $^{-1}$

Average effect of interaction between nano and bio fertilizer	Second season	first season	Bio fertilization	Nano Fertilization mg.L^{-1}
14.35 g	14.49 j	14.21 l	without inoculation	0
14.60 e	14.77 h	14.42 jk		Fe (160)
14.47 f	14.58 i	14.36 k		Co (3)
14.63 e	14.79 h	14.47 j		Fe (160) + Co(3)
15.47 d	15.71 f	15.23 g	inoculation	0
16.23 b	16.39 b	16.07 d		Fe (160)
16.07 c	16.23 c	15.91 e		Co (3)
16.44 a	16.59 a	16.29 c		Fe (160) + Co(3)
Average effect of interaction between nano and organic fertilizers	**Second season**	**first season**	**organic fertilization tons. dunums $^{-1}$**	**Nano Fertilization mg.L^{-1}**
14.46 m	14.62 pqr	14.29 s	0	0
14.74 k	14.89 n	14.58 qr	2	
15.01 j	15.31 hij	14.70 op	4	
15.46 f	15.59 g	15.32 hi	6	
14.81 j	14.95 n	14.67 opq	0	Fe 160 mg.L^{-1}
15.10 h	15.20 jk	14.99 mn	2	
15.55 e	15.77 f	15.32 hi	4	
16.21 b	16.41 b	16.01 d	6	
14.62 l	14.68 opq	14.55 r	0	Co 3 mg.L^{-1}
15.01 i	15.12 kl	14.90 n	2	
15.42 f	15.61 g	15.23 ij	4	
16.04 c	16.22 c	15.86 ef	6	
14.83 j	14.91 n	14.75 o	0	Fe (160) + Co (3) mg.L^{-1}
15.19 g	15.31 h	15.07 lm	2	
15.69 d	15.96 de	15.42 h	4	
16.43 a	16.57 a	16.29 c	6	

Continued Table No. (2- b)

The average effect of the interaction between the bio-organic fertilizer	Second season	first season	organic fertilization tons. dunums $^{-1}$	Bio fertilization
14.00 h	14.04 k	13.96 m	0	without inoculation
14.38 g	14.49 j	14.27 k	2	
14.68 f	14.90 h	14.46 j	4	
14.99 e	15.20 g	14.78 i	6	
15.35 d	15.53 f	15.17 g	0	inoculation
15.64 c	15.77 e	15.50 f	2	
16.15 b	16.42 c	15.88 d	4	
17.08 a	17.19 a	16.96 b	6	

Average effect of interaction between nano, bio, and organic fertilization	Second season	first season	organic fertilization tons. dunums $^{-1}$	fertilization	
				Bio	Nano
13.72 z	13.81 M	13.63 N	0	without inoculation	0
14.23 x	14.30 F-I	14.16 I-L	2		
14.56 tu	14.75 yz	14.37 D-G	4		
14.88 pq	15.08 tu	14.68 z-A	6		
15.18 lm	15.42 pqr	14.94 u-x	0	inoculation	
15.23 kl	15.47 opq	14.99 uvw	2		
15.45 j	15.86 jkl	15.03 tuv	4		
16.02 g	16.09 hi	15.95 ijk	6		
14.20 x	14.33 E-I	14.07 KL	0	without inoculation	Fe 160 mg.L^{-1}
14.43 vw	14.54 A-D	14.31 F-I	2		
14.72 rs	14.96 u-x	14.48 B-E	4		
15.04 no	15.26 rs	14.81 xyz	6		
15.41 j	15.56 nop	15.26 rs	0	inoculation	
15.76 i	15.86 jkl	15.66 mn	2		
16.36 e	16.57 e	16.15 gh	4		
17.38 b	17.55 b	17.21 c	6		
13.93 y	13.84 M	14.02 L	0	without inoculation	Co 3 mg.L^{-1}
14.36 w	14.46 C-F	14.25 G-J	2		
14.64 st	14.86 wxy	14.42 C-F	4		
14.97 op	15.17 st	14.76 yz	6		
15.30 k	15.51 n-q	15.08 tu	0	inoculation	
15.67 i	15.78 lk	15.55 nop	2		
16.20 f	16.35 f	16.04 hi	4		

17.12 c	17.27 c	16.96 d	6		
14.16 x	14.19 H-K	14.12 JKL	0	without inoculation	160) (3 + Fe + Co mg.L^{-1}
14.49 uv	14.64 zAB	14.34 E-H	2		
14.79 qr	15.02 t-w	14.55 ABC	4		
15.09 mn	15.30 rs	14.87 v-y	6		
15.50 j	15.62 no	15.38 qr	0	inoculation	
15.89 h	15.98 ij	15.79 klm	2		
16.59 d	16.90 d	16.28 fg	4		
17.77 a	17.84 a	17.70 ab	6		
15.12 b			first	Seasons effect	
15.44 a			Second		

Total grain yield (kg.h^{-1}):

The yield of grains represents the ability of the plant species to convert the largest possible amount of photosynthesis products to the grains and it depends on the size of the representations prepared from the source and the capacity of the grains in storing those products .The results appearing in Table (5-a, b) indicate that there is a significant difference in the average of the grain yield as a result of its influence by study factors and their bi and triple interaction. The individual treatments when fertilizing with micro-nano elements and at the level (iron 160 + cobalt 3) mg.L^{-1} and adding decomposed organic waste at an average of (6 tons.dunum-1) and inoculating seeds with rhizobia of the type (S.meliloti) recorded the highest averages for grain were (1284.37), 1583.34 and 1452.53 kg. ha^{-1}, respectively, compared with non-fertilized treatments that gave the lowest average for this trait. Also, the bi-interaction between the two fertilization treatments with nano microelements at the level (iron 160 + cobalt 3) mg.L^{-1} with seed inoculation with bacteria (S.meliloti) and the combination between the level (iron 160 + cobalt 3) mg.L^{-1} with and addition the decomposed organic waste at an average of (6 tons.dunum^{-1}) and the combination between seed inoculation with (*S.meliloti*) with the addition of the decomposed organic waste at an average of (6 tons.dunum^{-1}) gave the highest average yield of (1813.86), (1674.05) and (1997.73) kg.ha^{-1} respectively compared to the non-fertilized treatments .As for the effect of triple interaction, the interaction treatment was achieved between fertilization with nano macro elements at the level (iron 160 + cobalt 3) mg.L $^{-1}$ with *S. meliloti* seed inoculation and the addition of decomposing organic waste at an average of (6 tons. dunum^{-1}) excelled on all treatments and their interactions, by giving them the highest quantity of grain yield, which reached (2366.03), compared with the non-fertilized treatment, which gave a minimum average of yield (304.65) kg.ha^{-1}.With regard to the effect of seasons and their combinations with the study factors and their interactions, all of them had a significant effect on the number of pods. The treatments of the second season gave a significantly excelled in their effect on increasing the average grain yield amounted to (1341.78)

$kg.ha^{-1}$ compared with the first season, which recorded the lowest amount of yield amounted to (926.52) kg. ha^{-1}As for the interaction between the treatments and their combinations with the seasons, fertilization with nano macro elements and at the level (iron 160 + cobalt 3) mg. L^{-1} and the inoculation with Rhizobia type (S. meliloti) and the addition of decomposing organic waste at a rate of (6 tons. $dunum^{-1}$) and the bi-interaction between (iron 160 + cobalt 3) mg. L^{-1} × rhizobia inoculation (S. meliloti) and between (iron 160 + cobalt 3) mg. L^{-1} × decomposed organic waste at an average of (6 tons. $dunum^{-1}$) and (S.meliloti) rhizobia inoculation × S. meliloti inoculation and the triple combination between (iron 160 + cobalt 3) $mg.L^{-1}$ and inoculation with rhizobia type (S.meliloti) and the addition of decomposing organic waste at an average of (6 $tons.dunum^{-1}$) in the second season, the highest average in the amount of yield reached (1528.82) (1857.93), (1734.65), (2145.38), (1967.75), (2373.03) and (2777.72) $kg.ha^{-1}$ for the respectively, while the lowest averages for the trait were recorded in the non-fertilized treatment in the first season.

Table (5-a) The effect of organic and bio fertilization and spraying with some nanoparticles and seasons and their combinations on the average total yield of seeds (kg. ha^{-1}) of fenugreek plants.

Average fertilization effect			seasons		Fertilization treatments and levels	
organic	Bio	Nano	second	first		
		937.18	1090.90 d	783.46 h	0	Nano Fertilization $mg.L^{-1}$
		1193.18	1426.97 b	959.39 f	Fe (160)	
		1121.89	1320.45 c	923.32 g	Co (3)	
		1284.37	1528.82 a	1039.92 e	Fe160+Co 3	
	684.96 b		825.65 c	544.28 d	without inoculation	Bio fertilization
	1583.34 a		1857.93 a	1308.76 b	inoculation	
858.63 d			983.96 e	733.29 g	0	organic fertilization tons. $dunums^{-1}$
1017.32 c			1197.56 c	837.07 f	2	
1208.15 b			1450.96 b	965.33 e	4	
1452.53 a			1734.65 a	1170.40 c	6	
Average effect of interaction between nano and bio fertilizer			Second season	first season	Bio fertilization	Nano Fertilization $mg.L^{-1}$
604.83 h			720.10 k	489.55 n	without inoculation	0
718.49 f			876.11 i	560.86 m		Fe (160)
661.66 g			794.11 j	529.21 m		Co (3)

754.89 e	912.26 h	597.51 l		Fe (160) + Co(3)
1269.53 d	1461.69 d	1077.37 g	inoculation	0
1667.88 b	1977.84 b	1357.91 e		Fe (160)
1582.12 c	1846.80 c	1317.43 f		Co (3)
1813.86 a	2145.38 a	1482.34 d		Fe (160) + Co(3)
Average effect of interaction between nano and organic fertilizers	**Second season**	**first season**	**organic fertilization tons. dunums $^{-1}$**	**Nano Fertilization mg.L^{-1}**
681.32 l	768.97op	593.66 q	0	0
860.03 k	985.55 k	734.51 p	2	
966.03 i	1112.66 ij	819.39 no	4	
1241.35 e	1496.42 e	986.28 k	6	
923.47 j	1065.74 j	781.20 op	0	Fe 160 mg.L^{-1}
1071.16 g	1271.75 g	870.57 lm	2	
1283.90 d	1564.91 d	1002.89 k	4	
1494.20 b	1805.50 b	1182.90 h	6	
854.11 k	965.45 k	742.77 p	0	Co 3 mg.L^{-1}
1017.67 h	1191.56 h	843.78 mn	2	
1215.25 e	1455.84 e	974.66 k	4	
1400.53 c	1668.96 c	1132.09 i	6	
975.62 i	1135.69 i	815.54 no	0	Fe (160) + Co (3) mg.L^{-1}
1120.42 f	1341.40 f	899.43 l	2	
1367.42 c	1670.45 c	1064.39 j	4	
1674.05 a	1967.75 a	1380.34 f	6	

Continued Table No. (2- b)

The average effect of the interaction between the bio-organic fertilizer	Second season	first season	organic fertilization tons. dunums $^{-1}$	Bio fertilization
447.45 h	516.15 k	378.74 l	0	without inoculation
620.25 g	749.86 i	490.64 k	2	
764.83 f	940.29 h	589.36 j	4	
907.34 e	1096.28 g	718.39 i	6	
1269.80 d	1451.77 d	1087.83 g	0	inoculation
1414.39 c	1645.27 c	1183.50 f	2	

1651.47 b	**1961.64 b**	**1341.29 e**	**4**		
1997.73 a	**2373.03 a**	**1622.42 c**	**6**		
Average effect of interaction between nano, bio, and organic fertilization	**Second season**	**first season**	**organic fertilization tons. dunums $^{-1}$**	**fertilization**	
				Bio	**Nano**
304.65 A	**323.09 QR**	**286.20 R**	**0**	without inoculation	**0**
567.14 wx	**666.59 F-I**	**467.68 NO**	**2**		
710.59 st	**864.96 ABC**	**556.22 KLM**	**4**		
836.93 pq	**1025.76 xyz**	**648.10 G-J**	**6**		
1057.98 m	**1214.84 rs**	**901.11 AB**	**0**	inoculation	
1152.92 l	**1304.50 opq**	**1001.34 yz**	**2**		
1221.46 k	**1360.36 nop**	**1082.55 vwx**	**4**		
1645.77 e	**1967.07 e**	**1324.46 op**	**6**		
509.23 y	**604.34 IJK**	**414.11 OP**	**0**	without inoculation	**Fe 160 mg.L^{-1}**
642.19 uv	**787.61 DE**	**496.76 MN**	**2**		
788.66 qr	**979.15 z**	**598.16 JKL**	**4**		
933.88 o	**1133.34 t-w**	**734.42 EF**	**6**		
1337.71 i	**1527.13 jk**	**1148.28 s-v**	**0**	inoculation	
1500.13 g	**1755.89 g**	**1244.37 qr**	**2**		
1779.14 d	**2150.67 d**	**1407.61 mn**	**4**		
2054.52 b	**2477.66 b**	**1631.37 hi**	**6**		
428.55 z	**490.29 MN**	**366.80 PQ**	**0**	without inoculation	**Co 3 mg.L^{-1}**
597.67 wv	**707.27 FG**	**488.07 MN**	**2**		
743.96 rs	**910.61 A**	**577.30 JKL**	**4**		
876.47 p	**1068.25 wxy**	**684.68 FGH**	**6**		

1279.67 j	**1440.61ml**	**1118.73 uvw**	**0**	inoculation	
1437.66 h	**1675.84 h**	**1199.48 rst**	**2**		
1686.54 e	**2001.07 e**	**1372.01mno**	**4**		
1924.58 c	**2269.66 c**	**1579.50 ij**	**6**		
547.38 xy	**646.89 G-J**	**447.86 NO**	**0**	without inoculation	**160) (3 + Fe + Co $mg.L^{-1}$**
674.01 tu	**837.95 BCD**	**510.06 LMN**	**2**		
816.11 q	**1006.44 yz**	**625.77 H-K**	**4**		
982.06 n	**1157.77 stu**	**806.35 CD**	**6**		
1403.85 h	**1624.48 hi**	**1183.21 r-u**	**0**	inoculation	
1566.83 f	**1844.85 f**	**1288.80 pq**	**2**		
1918.73 c	**2334.45 c**	**1503.00 kl**	**4**		
2366.03 a	**2777.72 a**	**1954.33 e**	**6**		
926.56b			**first**	**Seasons effect**	
1341.78 a			**Second**		

Discussion :

The increase in the traits of the number of pods, the number of seeds, the weight of a 1000 grain , and the total yield of the seeds may explain the positive role played by the study factors and their levels of mineral fertilization with the elements of iron and cobalt nanoparticles, bio-fertilization with root-forming bacteria (S.meliloti) and organic fertilization with decomposed sheep manure in Improving plant growth and activating the physiological activities that occur inside the plant,The nano iron is characterized by its small size compared to the pores of the cell wall, which allows the plant to absorb it easily and faster and participate in the activation of many enzymatic systems that enter into the synthesis of its proteins such as enzymes of electron transport in the steps of respiration and energy production (catalase, cytochrome oxidase, cytochrome) (Jonce, 2012)and the enzymes associated with stimulating the biological pathway for chlorophyll synthesis, protein building, and root meristem growth (Connorton et al., 2017), and stimulation of the electron transport system during the photophosphorylation process in the second photosystem that occurs in plastids at the thylocoid level to enter the ferredoxin protein synthesis and stimulate the enzymatic system of bacteria (S. meliloti) by entering the composition of the nitrogenase enzyme responsible for reducing bio-inactive atmospheric nitrogen and providing it to plants in the form of ammonia. 2018),In addition to the important biological role of cobalt nanoparticles in stimulating plant metabolism and growth processes by inhibiting the biological pathway of ethylene synthesis that causes plant senescence, in addition to reducing the activity of the enzyme (peroxidase) that breaks down the auxin molecule (IAA) (Minz et al., 2018), and the primary role of cobalt in The success of the atmospheric nitrogen fixation process through the participation in the formation of colpamine and colpamine coenzyme complexes, which participate with other enzymes such as(Mwthylmlloonyl Co-isomerase, glutamate mutase, Glycerol dehydrates, dioldehydeotase, Ethanlamine deaminase, B-Lysine mutase) in transporting the hydrogen molecule group (H) during the reduction of atmospheric nitrogen to ammonia, in addition to its participation in the formation of a protein (Legheamoglobin) responsible for protecting the enzyme. Nitrogenase from oxidative stress processes in root ganglia (Lui, 1998 and Havlin et al., 2014). The overall positive biological effects of the two elements, iron and cobalt, may have a great role in building the effective enzymatic and hormonal system of the plant and activating many physiological processes such as photosynthesis, respiration and cell division, which leads to the growth of an ideal vegetative system of the plant, which is reflected positively in these traits, and these results are consistent with a study that is consistent with it. With results reached (Delfani et al., 2014 and Sharma et al., 2019 and Yassin, 2019) Regarding the iron and what it found (Tomic et al., 2014 and Gad and Abdel moez, 2015) for the element cobalt. While the increase in the average of traits (number of pods, number of seeds, weight of a thousand grains, and total seed yield) when treated with bio fertilization with bacteria (S. meliloti) may be due to the activation of the overall metabolic processes that occur in the plant through the process of fixing atmospheric nitrogen and providing an element Nitrogen in a form usable by the plant, which is an essential element in building the enzymatic and hormonal system and the formation of chlorophyll and the protein content of the plant, which leads to stimulating plant growth thanks to the activation of the photosynthesis process and the accumulation of its products from the organic materials necessary for growth, in addition to its positive effect on root growth and increasing the area spread in the soil, and its secretions of plant hormones (auxins, gibberellins, cytokinins) in the Root nodules, all of which may be positively reflected in the rate of these traits. These results are consistent with what (Pawar et al., 2014, Singh and Patel, 2016 and Zagloul, 2019) and the findings of Meena et al., 2015 and Godara et al., 2017).While the increase in the number of pods, the number of seeds, the weight of a thousand grains, and the total yield of the seeds through treatment with the decomposing organic waste of sheep may explain the improvement that occurred in the conditions of root growth by improving the natural properties of the soil (porosity, ability to retain water, cohesion of soil groups. Silt and clay) and the fertility traits of the soil (enriching the soil with some elements necessary for growth) and its vital activity, This is positively reflected in the formation of a large root and vegetative growth, which activates many of the plant's physiological processes, such as the absorption of nutrients and water, stimulation of the process of photosynthesis and respiration and the release of energy particles, and this may increase the metabolism and production of plant growth materials, causing a large vegetative growth represented by the increase in plant height and the number of branches and a large leaf area, which is reflected in its positive effects in the formation of a large number of pods with a high content of plump seeds and thus an increase in the rate of seeds produced per unit area, and these results are consistent with what was mentioned by both (Ciancio and others, 2014 and Golijan and Murkovic, 2018). Results together with findings (Otieno et al. 2009 and Abrahim et al., 2013).

Conclusions:

1- The fenugreek plant showed a positive response to spraying with chelated metallic micro-elements with the concentrations that were sprayed, and the best of these treatments was spraying with iron and cobalt together at a concentration of 016 and 3 mg. L^{-1} in sequence, which significantly affected the yield trait and its components.

2- Bio-fertilization with the diagnosed bacterial inoculum (Sinorhzobium meliloti) of fenugreek seeds showed a high significant response to all traits included in the study.

3- The results of the study showed that organic fertilization using different levels of decomposing sheep manure caused significant increases in the yield traits and its components, and that the best of these levels is the addition of 6 tons. $Dunum^{-1}$ of decomposing organic waste.

4- The bi and triple combinations between fertilization with chelated nano micro-elements and bio fertilization (S. meliloti bacterial inoculum) and organic fertilization with decomposing sheep manure at its different levels had a significant effect in increasing the studied traits and the best of these combinations is the triple combination of treatments that gave the highest values in the studied traits. By providing balanced nutritional conditions for the plants by providing the necessary elements for growth in a manner that made the plants grow better than their counterparts in bi and individual combinations of treatments and non-fertilized treatments.

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