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EFFECT OF BIO-FERTILIZER AND SPRAYING WITH NANO-FERTILIZER AND GIBBERELLIN ON THE VEGETATIVE GROWTH OF *ALOE VERA* L.

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Abstract

This study was conducted in the lathhouse of the Department of Plant Production Techniques / Musayyib Technical College during the period from 1/9/2021 to 1/6/2022 to study the effect of biofertilization and spraying with nano-fertilizer and gibberellin on the growth of Aloe vera plants. The experiment included three factors, three levels of biofertilization (without addition, azotobacter, mycorrhiza) and their symbols (E0, E1, E2) respectively, and spraying with nano iron fertilizer in three concentrations (0, 1500, 3000) mg L^{-1} and symbolizing them (Fe0, Fe1, Fe2) respectively, and gibberellin in three concentrations (0, 150, 300) mg L^{-1} and symbolizing them (G0, G1, and G2).The experiment was conducted as a factorial experiment according to Randomized Complete Blocks Design (R.C.B.D) with three replications and the averages were compared according to the least significant difference (L.S.D) test under the 5% probability level, and the results were as follows: The treatments of the addition of azotobacter and spraying with nano iron concentration of 3000 mg L^{-1} and gibberellin concentration of 300 mg L^{-1} were significantly excelled in all studied traits. It also caused the bi-interaction (mycorrhizal + nano iron 3000 mg L^{-1}), (Mycorrhizae + gibberellin 300 mg L^{-1}) and (Nano iron 3000 mg L^{-1} + gibberellin 300 mg L^{-1}) and the triple interaction between the study factors (mycorrhizalgia + nano iron 3000 mg L^{-1} + gibberellin 300 mg L^{-1}) was a significant increase in most of the studied traits.

Keywords: gibberellin, vegetative growth, *Aloe vera* L.

Introduction

Aloe vera, L refers to the genus Aloe, which includes more than (300) species, all of which are classified within the Asphodelaceae family. The origin country of this plant is in North Africa and Spain. It is also cultivated in hot and dry areas of Asia, Europe and America. Aloe vera has been used medicinally to treat a cultivar of diseases such as mild fever, wounds, burns, digestive disorders, diabetes, cancer and various skin diseases. As for the pharmaceutical industry, it is used in the manufacture of topical products such as ointments and cosmetics, and in pharmaceutical laboratories, and is superior to its analogues made from chemicals (Manvitha et al., 2014). Fresh Aloe vera gel is also used in the manufacture of energy drinks because it contains a group of important amino acids for building the human body, in addition to its use in the manufacture of creams and cosmetics. Aloe vera products are presented in the market in the form of juices or nutritional supplements in the form of dried powder or capsules containing Aloe vera extracts (Bhandari, 2010). In recent years, a lot of studies and research have appeared that dealt with the introduction of nanotechnology in the agricultural field, which is called. Agro-Nanotechnology Nano-fertilizers have unique properties due to their small size and large surface area, which leads to an increase in the absorption surface and then an increase in the process of photosynthesis and thus increased production in the plant (Singh et al., 2016). With the increase in the percentage of pollution by residues in the various agricultural crops and the consequent rejection of the exported shipments, which causes losses to the national economy, it was necessary to resort to various methods to avoid this and to maximize the return from the agricultural process. Accordingly, the use of various nano compounds, including iron, which is one of the micronutrients necessary for plant growth and has an effect on increasing the quantity and quality of various agricultural crops, iron directly enters the formation of cytochromes and some enzymes, and in the formation of (Ferrodoxin) and has a role in the formation of chlorophyll although It is not included in its composition (Briat et al., 2015). Scientific studies have also confirmed the importance of biological, bacterial and fungal fertilizers in increasing agricultural production because of their important role in improving plant growth by increasing the availability of the necessary elements needed for plant growth, such as nitrogen, which is fixed by Azotobacter and phosphorous, which is prepared by the mycorrhizal fungi, and its reduction in the soil reaction number (pH), which increases the available of microelements needed by the plant, as well as for the production of growth regulators such as auxins, cytokines and gibberellins. In addition to improving soil properties, Mycorrhizae secrete coumalin, which works to hold soil particles and increase the soil's ability to retain water, as it increases the plant's ability to resist biotic and abiotic stresses (Adeleke, (2010) and Khalaf, 2013). Gibberellins are plant hormones that promote growth, affect stem elongation by stimulating cell elongation and overcoming genetic dwarfism, encourage cell division and expansion, regulate carbohydrate permeability and activate nucleic acid formation. The treatment with gibberellin contributes to a greater shift of nutrients towards the growth sites (Davies, 2004).

Material and methods:

A factorial experiment was conducted in the lathhouse of the Department of Plant Production Techniques / Al-Musauib Technical College for the period from 1/9/2021 to 1/6/ with three replications according to the randomized complete block design (RCBD).To study the effect of bio-fertilization three levels (without addition, Azotobacter chrococcim, Mycorrhizae Glomus spp) and symbolized by them (E2, E1, E0)) respectively and spraying with nano fertilizer (Nano Iron) (0, 1500, 3000) mg L^{-1} and symbolized by them (F2, F1 ,F0) , Gibberellins GA3 (0, 150, 300) mg L^{-1} and their symbol is G2, G1, G0) respectively in the chemical traits of Aloe vera L.Bio-fertilizer was added to the soil of seedlings with an amount of 3 cm per pot, which was obtained from the Ministry of Science and Technology. Then the plants were sprayed after irrigation with a bio-fertilizer solution (nano chelate) and the next day it was sprayed with gibberellin acid in the early morning until complete wetness and by four sprays (15) 10 and 15/11/2021 and 1/4 and 1/5/2022 The service operations of irrigation and weeding were conducted whenever needed. After the experiment was completed, the following measurements were taken:

1-plant height (cm)

The height of the plant was measured from its contact with the soil to its highest end using a metric tape measure.

2- number of leaves (leaf plant^{-1})
All plant leaves were calculated and then the average number of leaves per plant was extracted within one treatment.
3- leaf thickness (mm)
Scaled similarly to leaf width by digital footprint.
4- Weight of green tissue in the leaf (cortex) (g)
The peel was weighed after removing it from the gel with a knife.
5- The fresh weight of the leaf
Three leaves of the second row were cut from the place where they were connected to the plant and then weighed, then the average weight of one leaf was extracted, then the average was taken for each replicate and then for each treatment.

Results

1- plant height (cm)

The results in table (1) showed the biofertilization Azotobacter significantly excelled in plant height and recorded 42.78 cm compared to the control treatment, which recorded 37.56 cm. 43.21 cm ,compared to the control treatment, which recorded 38.08 cm, while the two treatments of spraying with gibberellin at a concentration of 300 and 150 mg L^{-1} significantly, and recorded 44.85 and 42.49 cm compared to the control treatment, which recorded 40.22 cm. The same table also showed that the two interactions in the treatments had a significant effect on plant height. The interaction treatment between mycorrhizae and spraying with nano iron at a concentration of 3000 mg L-1 excelled, the highest average in height was 50.97 cm, followed by the treatment (Mycorrhizal + spraying with nano iron 1500 mg L^{-1}) It was recorded 48.87 cm compared to the control treatment, which recorded 34.59 cm. While the bilateral interaction between the bio fertilization with Mycorrhizae and spraying with gibberellin at a concentration of 300 mg L^{-1} gave the highest rate of 49.02 cm compared to" the control treatment, which recorded 35.44 cm. The interaction coefficients between spraying with nano iron at a concentration of 3000 mg L^{-1} and spraying with gibberellin at a concentration of 300 mg L^{-1} recorded the highest average in plant height that reaching 49.12 cm compared to the comparison treatment 36.37 cm. The triple interaction between the study factors resulted in a significant increase in the plant height, where the triple interaction treatment (Mycorrhizae + spraying with nano iron 3000 mg L^{-1} + spraying with gibberellin 300 mg L^{-1}) was recorded.The highest measured height was 54.88 cm, with the control treatment, which was 33.14 cm.

Table 1. Effect of biofertilization and spraying with nano iron and gibberellin on plant height (cm)

Bio Fertilization	Spraying with nano iron (mg L-1)	Spraying with gibberellin (mg L-1)			Bio Fertilization *Nano Iron
		0	150	300	
without adding	0	33.14	34.81	35.83	34.59
	1500	35.85	37.43	39.76	37.68
	3000	37.32	40.33	43.51	40.39

Azotobacter	0	34.71	37.08	41.72	37.84
	1500	38.98	43.41	46.83	43.07
	3000	46.63	46.73	48.97	47.44
Mycorrhiza	0	41.25	42.04	42.18	41.82
	1500	47.40	49.22	49.99	48.87
	3000	46.69	51.34	54.88	50.97
LSD 0.05		3.272			1.889
Biofertilization * Gibberellin					Fertilization average
without adding		35.44	37.53	39.70	37.56
Azotobacter		40.11	42.40	45.84	42.78
Mycorrhiza		45.11	47.53	49.02	47.22
LSD 0.05		1.889			1.091
Nano iron * gibberellin					average nano iron
0		36.37	37.98	39.91	38.08
1500		40.74	43.35	45.53	43.21
3000		43.55	46.13	49.12	46.27
LSD 0.05		1.889			1.091
Average spraying with gibberellin		40.22	42.49	44.85	
LSD 0.05		1.091			

2- The number of leaves (leaf.plant^{-1})

The results in Table (2) indicate the biofertilization with Mycorrhizae and Azotobacter significantly excelled in the number of leaves 17.58 and 15.64 leaf.plant^{-1}, respectively, compared to the control treatment, which recorded 13.72 leaf.plant^{-1}.The results of the table also showed treatment with nano iron concentrations of 3000 and 1500 mg L^{-1} significantly excelled, and gave 16.95 and 16.07 leaf.plant^{-1}, respectively, compared to the control treatment, which recorded 13.93 leaf.plant^{-1} While the two treatments of spraying with gibberellin at a concentration of 300 and 150 mg L^{-1} were significantly excelled and scored 16.74 and 16.13 leaf.plant^{-1}compared to the control treatment which recorded 14.08 leaf.plant^{-1}.The results of the table also showed that the two interactions in the treatments had a "significant" effect on the number of leaves. The interaction treatment between mycorrhiza and spraying with nano iron at a concentration of 3000 mg L^{-1} excelled the highest average in the number of leaves, which amounted to 19.43 leaf.plant^{-1}.It was followed by the treatment (Mycorrhiza + spraying with nano iron 1500 mg L^{-1}), which recorded 17.71 leaf.plant^{-1}compared to the control treatment, which recorded 12.05 leaf.plant^{-1}.While the bi- interaction between the biofertilization with Mycorrhizae and spraying with gibberellin at a concentration of 300 mg L^{-1} gave the highest average of 19.23 leaf.plant^{-1}compared to the comparison treatment which recorded 12.25 leaf.plant^{-1}.The interaction between spraying with nano iron at a concentration of 3000 mg L^{-1} and spraying with gibberellin at a concentration of 300 mg L^{-1} recorded the highest rate in the number of leaves which was 18.09 leaf.plant^{-1}, compared to the control treatment 12.67 leaf.plant^{-1}.The triple interaction between the study factors led to a significant increase in plant height, as the triple interaction treatment (mycorrhizal + spray with nano iron 3000 mg L^{-1} + spray with gibberellin 300 mg L^{-1}) recorded the highest rate in the number of leaves reached 21.99 leaf.plant^{-1}compared to with the control treatment, which recorded 10.45 leaf.plant^{-1}

Table 2 Effect of biofertilization and spraying with nano iron and gibberellin on the number of leaves (leaf.plant^{-1})

Bio Fertilization	Spraying with nano iron (mg L-1)	Spraying with gibberellin (mg L-1)			Bio Fertilization *Nano Iron
		0	150	300	
without adding	0	10.45	12.42	13.29	12.05
	1500	12.55	14.29	16.07	14.30
	3000	13.74	15.91	14.79	14.81
Azotobacter	0	13.51	14.41	14.41	14.11
	1500	15.04	16.61	16.96	16.20
	3000	15.37	16.93	17.48	16.59
Mycorrhiza	0	14.04	16.32	16.47	15.61
	1500	15.48	18.44	19.22	17.71
	3000	16.50	19.79	21.99	19.43
LSD 0.05		1.1336			0.6545
Biofertilization * Gibberellin					Fertilization average
without adding		12.25	14.21	14.72	13.72
Azotobacter		14.64	15.98	16.28	15.64
Mycorrhiza		15.34	18.18	19.23	17.58
LSD 0.05		0.6545			0.3779
Nano iron * gibberellin					average nano iron
0		12.67	14.38	14.72	13.93
1500		14.36	16.45	17.42	16.07
3000		15.20	17.54	18.09	16.95
LSD 0.05		0.6545			0.3779
Average spraying with gibberellin		14.08	16.13	16.74	
LSD 0.05		0.3779			

3- Thickness of leaves (mm)

The results in Table (3) showed that the biofertilization with Mycorrhizae and Azotobacter was significantly excelled in leaf thickness, which were 12.12 and 10.78 mm, respectively, compared to the control treatment, which recorded 8.12 mm.The results of the table also showed that the two treatments of spraying with nano iron concentration of 3000 and 1500 mg L^{-1} were significantly excelled and gave 11.97 and 10.36 mm respectively compared to the control treatment which recorded 8.69 mm .While the two treatments of spraying with gibberellin at a concentration of 300 and 150 mg L^{-1} significantly excelled 11.09 and 10.69 mm compared to" the control treatment which recorded 9.24 mm.The results of the table also showed that the two interactions in the treatments had a "significant" effect on leaf thickness. The interaction treatment between mycorrhizal and spraying with nano iron at a concentration of 3000 mg L^{-1} excelled and gave the highest rate in leaf thickness of 14.35 mm. This was followed by the treatment (Mycorrhiza + spraying with nano iron 1500 mg L^{-1}) and it recorded 11.94 mm of measurement, compared to the control treatment, which recorded 6.51 mm. While the bi-interaction between the biofertilization with Mycorrhizae and spraying with gibberellin at a concentration of 300 mg L^{-1} gave the highest average of 13.41 mm compared to the control treatment which recorded 7.21 mm.

The interaction between spraying with nano iron at a concentration of 3000 mg L^{-1} and spraying with gibberellin at a concentration of 300 mg L^{-1} recorded the highest rate in leaf thickness of 12.98 mm, compared to the control treatment of 7.27 mm.The triple interaction between the study factors recorded a significant increase in leaf thickness, as the triple interaction treatment (mycorrhizal + spraying with nano iron 3000 mg L^{-1} + spraying with gibberellin 300 mg L^{-1}) recorded.The highest average was 16.57 mm compared to the control treatment, which recorded 5.27 mm.

Table 3. Effect of biofertilization and spraying with nano iron and gibberellin on leaf thickness (mm)

Bio Fertilization	Spraying with nano iron (mg L-1)	Spraying with gibberellin (mg L-1)			Bio Fertilization *Nano Iron
		0	150	300	
without adding	0	5.27	7.00	7.27	6.51
	1500	7.19	8.33	8.43	7.98
	3000	9.17	9.81	10.59	9.86
Azotobacter	0	8.70	9.48	10.27	9.48
	1500	10.89	11.29	11.25	11.14
	3000	10.97	12.41	11.77	11.72
Mycorrhiza	0	7.85	11.11	11.25	10.07
	1500	11.43	12.00	12.40	11.94
	3000	11.72	14.76	16.57	14.35
LSD 0.05		0.6704			0.3871

Biofertilization * Gibberellin				**Fertilization average**
without adding	**7.21**	**8.38**	**8.76**	**8.12**
Azotobacter	**10.19**	**11.06**	**11.09**	**10.79**
Mycorrhiza	**10.33**	**12.62**	**13.41**	**12.12**
LSD 0.05	**0.3871**			**0.2235**
Nano iron * gibberellin				**average nano iron**
0	**7.27**	**9.19**	**9.59**	**8.69**
1500	**9.84**	**10.54**	**10.69**	**10.36**
3000	**10.62**	**12.33**	**12.98**	**11.97**
LSD 0.05	**0.3871**			**0.2235**
Average spraying with gibberellin	**9.24**	**10.69**	**11.09**	
LSD 0.05	**0.2235**			

4- Weight of green tissue in the leaf (cortex) (g)

The results in Table (4) showed the significantly ecelled of the biofertilization with Mycorrhizae and Azotobacter in green tissue weight and recorded 77.90 and 61.77 g, respectively, compared to the control treatment, which recorded 54.14 g.The results of the table also recorded the significantly of the spray treatment with nano iron concentrations of 3000 and 1500 mg L^{-1} significantly, and they gave 73.43 and 64.68 g, respectively, compared to the control treatment, which recorded 55.70 g, While the treatment of spraying with gibberellin at a concentration of 300 and 150 mg L^{-1} significantly, and recorded 70.47 and 66.44 measurements, was significantly excelled to the control treatment, which recorded 56.90 g.The results of the table also showed that the two interactions in the treatments had a "significant" effect on the weight of green tissues. The interaction treatment between mycorrhizal and spraying with nano iron at a concentration of 3000 mg L^{-1} excelled and gave the highest average in the weight of green tissues, which was 94.33 g.It was followed by the treatment (Mycorrhizal + spray with nano iron 1500 mg L^{-1}) and recorded 78.24 g , and the treatment of (Azotobacter + spraying with nano iron 3000 mg L^{-1}) and recorded 70.05 g compared to the control treatment which recorded 51.99 gm. Whereas, the dual interaction treatments between mycorrhizal biofertilization and gibberellin at a concentration of 300 mg L^{-1} gave the highest rate of 87.66 g, followed by the treatment (Mycorrhizal + spraying with gibberellin at a concentration of 150 mg L^{-1}) which recorded 81.89 g compared to the control treatment which recorded 51.59 g.The interaction between spraying with nano iron at a concentration of 3000 mg L^{-1} and spraying with gibberellin at a concentration of 300 mg L^{-1} recorded the highest average in green tissue weight of 81.23 g, followed by the treatment (spraying with nano iron at a concentration of 3000 mg L^{-1} + spraying with gibberellin at a concentration of 150 mg L^{-1}), which recorded 76.05 g,The excelled of (spraying with nano iron at a concentration of 1500 mg L^{-1} + spraying with gibberellin at a concentration of 300 mg L^{-1}, which recorded 71.26 g as a measurement) compared to the control treatment 51.69 g.The triple interaction between the study factors showed a significant increase in the weight of green tissues, where the triple interaction treatment (mycorrhizal + spray with nano iron 3000 mg L^{-1} + spray with gibberellin 300 mg L-1) recorded the highest weight of green tissue amounted to 108.57 g compared to "the control treatment that Recorded 50.55 g.

Table 4) Effect of biofertilization and spraying with nano iron and gibberellin on the weight of green tissues in the leaf (gm)

Bio Fertilization	Spraying with nano iron (mg L-1)	Spraying with gibberellin (mg L-1)			Bio Fertilization *Nano Iron
		0	150	300	
without adding	0	50.55	52.05	53.36	51.99
	1500	51.67	54.29	57.57	54.51
	3000	52.55	57.62	57.58	55.92
Azotobacter	0	51.76	52.33	57.86	53.98
	1500	54.07	62.47	67.32	61.29
	3000	59.10	73.52	77.54	70.05
Mycorrhiza	0	52.77	65.11	65.53	61.14
	1500	62.27	83.56	88.88	78.24
	3000	77.40	97.02	108.57	94.33
LSD 0.05		3.572			2.062
Biofertilization * Gibberellin					Fertilization average
without adding		51.59	54.66	56.17	54.14
Azotobacter		54.98	62.77	67.57	61.77
Mycorrhiza		64.15	81.89	87.66	77.90
LSD 0.05		2.062			1.191
Nano iron * gibberellin					average nano iron
0		51.69	56.50	58.92	55.70
1500		56.00	66.77	71.26	64.68
3000		63.02	76.05	81.23	73.43
LSD 0.05		2.062			1.191
Average spraying with gibberellin		56.90	66.44	70.47	
LSD 0.05		1.191			

5- Fresh weight of the leaf (gm)

The results in Table (5) showed that the biofertilization with Mycorrhizae and Azotobacter was significantly excelled in the fresh weight of the leaf, which recorded 79.38 and 66.05 g, respectively, compared to the control treatment, which recorded 57.79 g.The results of the table below showed that the two treatments of spraying with nano iron concentrations of 3000 and 1500 mg L^{-1} were significantly excelled, and they gave 77.12 and 67.06 gm, respectively, compared to the control treatment, which recorded 59.04 g, while the two treatments of spraying with gibberellin at a concentration of 300 and 150 mg L^{-1} were significantly excelled and recorded 71.85 and 67.97 gm measured" with the control treatment, which recorded 63.41 gm. The results of the table also showed that the two interactions in the treatments had a “significant” effect on the fresh weight of the leaf. The interaction between the mycorrhizal and spraying with nano iron at a concentration of 3000 mg L^{-1} excelled the highest rate in the fresh weight of the leaf was 97.65 g, followed by the treatment (Mycorrhiza + Spraying with nano iron 1500 mg L^{-1}) recorded 77.91 gm compared to the control treatment, which recorded 55.16 gm.Whereas, the bi-interactions between Mycorrhiza biofertilization and gibberellin at a concentration of 300 mg L^{-1} gave the highest average of 85.99 g compared to the control treatment which recorded 54.91 g. The interaction between spraying with nano iron at a concentration of 3000 mg L^{-1} and spraying with gibberellin at a concentration of 300 mg was also recorded had the highest average fresh weight of the leaf reached 82.55 g, compared to the control treatment 56.27 g.The triple interaction between the study factors led to a significant increase in the fresh weight of the leaf, as the triple interaction treatment (mycorrhizal + spraying with nano iron 3000 mg L^{-1} + spraying with gibberellin 300 mg L^{-1}) recorded the highest fresh weight of the leaf amounted to 106.90 g compared to "the control treatment that Recorded 53.35 g.

Table 5: Effect of biofertilization and spraying with nano iron and gibberellin on the fresh weight of the leaf (gm)

Bio Fertilization	Spraying with nano iron (mg L-1)	Spraying with gibberellin (mg L-1)			Bio Fertilization *Nano Iron
		0	150	300	
without adding	0	53.35	55.48	56.65	55.16
	1500	55.51	58.42	60.17	58.03
	3000	55.89	61.73	62.87	60.16
Azotobacter	0	55.73	59.87	62.53	59.38
	1500	61.51	65.61	68.58	65.23
	3000	69.39	73.40	77.87	73.55
Mycorrhiza	0	59.73	61.28	66.76	62.59
	1500	70.58	78.83	84.30	77.91
	3000	88.98	97.07	106.90	97.65
LSD 0.05		3.566			2.059
Biofertilization * Gibberellin					Fertilization average

without adding	**54.91**	**58.54**	**59.90**	**57.79**
Azotobacter	**62.21**	**66.29**	**69.66**	**66.05**
Mycorrhiza	**73.10**	**79.06**	**85.99**	**79.38**
LSD 0.05	**2.059**			**1.189**
Nano iron * gibberellin				**average nano iron**
0	**56.27**	**58.88**	**61.98**	**59.04**
1500	**62.53**	**67.62**	**71.02**	**67.06**
3000	**71.42**	**77.40**	**82.55**	**77.12**
LSD 0.05	**2.059**			**1.189**
Average spraying with gibberellin	**63.41**	**67.97**	**71.85**	
LSD 0.05	**1.189**			

Discussion

The results in Tables (1-5) showed the significantly excelled of biofertilization with Mycorrhizae Azotobacter in the vegetative characteristics. And increasing the surface of the root system, leads to an increase in the absorption of water and nutrients, and this is reflected in the improvement of the vegetative growth of the plant, in addition to the role of bacteria in the process of fixing atmospheric nitrogen. It converts nitrogen from the inactive form (N2) to ammonia, or converts it from the form of ammonia to nitrates in order for it to be ready for absorption with the help of the nitrogenase enzyme (Sharma, 2019). In addition to its role in the production of plant hormones such as auxin, gibberellin and cytokinin, which help to increase the rate of cell division and elongation, increase their size and increase the level of intracellular metabolism, which is reflected in an increase in the vegetative growth characteristics of the plant represented (plant height, number of leaves, leaf thickness, tissue weight The green leaf in the leaf, the fresh weight of the leaf (Table 1, 2, 3, 4, 5). The results of Tables (1-5) showed the excelled of high concentrations of nano-fertilizer in the vegetative characteristics. The important enzymes related to the process of photosynthesis and thus increase the nutrients manufactured in the leaves, which are used in building the plant's vegetative system (Focus, 2003), and this is consistent with what Basiouny and Biggs (1976) and Hurley et al. (1986) have stated that iron has a role in increasing the speed and outputs of photosynthesis that are used in various growth processes, as well as increasing the amount of the two growth hormones IAA and GA3 in leaves, which work on The increase in cell division and expansion, which causes an increase in the characteristics of vegetative growth (Tables (1, 2, 3, 4, 5) and the root of the plant, as mentioned above (Gindia, 2003 and Sekhon, 2014 and Tanou et al., 2017 and Al-Asadi and Ali, 2019), In addition, iron is included in the composition of many non-heme compounds, the most important of which is Ferredoxin, which contributes to the transfer of electrons in many vital processes within the plant, including photosynthesis. Iron also enters the composition of the enzymes Nitrogenase, aconitase and xanthin oxidase with different functions within the plant (Marschner, 1986 and Phogat et al., 2016), The increase in vegetative growth and its activity in the manufacture of nutrients increases the supply of the roots with a quantity of these materials, which leads to an increase in their depth and spread (Kamiab and Zamanibahramabadi, 2016). And the process of building chlorophyll and increasing the processed food products, which helps in increasing cell division and then increasing the plant height (Abu Dahi and Younes, 1988),It is noticeable that the results of this experiment agree with what Najib (2003) reached in his study on the thyme plant and with Abu Khumra (2009) in her study on the gardenia jasminoides Ellis plant .The reason for the increase in the leaf area of plants treated with a high concentration of iron is due to its role in increasing the number of leaves (Table 3), and these results agreed with the findings of Al-Atabi (2012) in her study of the Eruca vesicaria plant and with Al-Ali (2011) in her study of the Dahlia plant and with Abu Khumra (2009)On the Gardenia plant, and this agrees with the results of Al-Absawy (2021) in his study of the moringa plant, Soliman et al. (2015) in his study of the moringa plant, Al-Khalifawi (2017) on the moringa plant. The results shown in Table (1-5) that spraying gibberellin on the vegetative characteristics had a “significant” effect, as high concentrations of gibberellin led to a significant increase in the vegetative characteristics (plant height, number of leaves, leaf thickness, weight of green tissues in the leaf, fresh weight of the leaf). , the reason for plant height (Table 2), its increase may be attributed to the effect of gibberellic acid in increasing cell division in the apical meristem area, which encourages plant elongation and increase in height (Yassin, 2001), and the role of gibberellin in activating the construction of DNA and RNA increases the construction of some enzymes such as Alpha amylase Which works on the analysis of starch in the cell, which increases its osmotic effort and then its water absorption and expansion, and this can explain the increase in the area of the leaves and the relative water content in them (Al-Rubaie et al., 1996),As for the increase in the number of branches, it can be due to the role of gibberellins in increasing plant growth and thus increasing the growth of roots and the ability to absorb elements such as nitrogen and phosphorous, which stimulate the building of cytokinins, which encourages the growth of side branches (Mohammed and Younis, 1991).The reason is the role of gibberellin acid in activating the construction of DNA and RNA, which increases the production of some enzymes such as α-amylase, which works to break down the starch in the cell into sugars, which increases its osmotic effort, and then the cells absorb water and swell, which leads to their expansion (Taiz and Zeger, 2010, moore, 1979),This significant increase in nutrients may be due to the role of gibberellin acid in increasing and improving vegetative growth indicators, number of leaves, leaf thickness, green tissue weight and fresh weight (table 2, 3, 4, 5). This is consistent with the study of Al-Khalifawi (2017) of the Moringa plant, Muhammad (2021) on the mint plant, Abbas and Sahn (2012) in spraying carnation plants, Janowska (2013) for kala, Singh and Rani (2013) for tuberose bulbs, Sardoei and Asil (2014) for aralia, Zubaidi (2010) for sweet bean, Al-Saadi et al. (2012) for fenugreek Sardoei, (2014) for the aloe vera plant, Sardoei et al. (2013) for the aloe vera plant, Mahdi (2021) for the gold stick plant.

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