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The effect of seaweed, nitrogen, and iron on some medicinally active (*Trigonella foenum-graecum* L.) compounds in the seeds of the fenugreek plant

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Abstract

A field experiment was carried out to study the effect of marine algae, nitrogen and iron on some medically active compounds of fenugreek plant seeds. In the field of experiments of Ibn Al-Bitar Vocational Preparatory School of the Directorate of Education in Holy Karbala, Department of Vocational Education during the winter season 2024-2023, The design of RCBD was used in the order of splinter plates, three repeaters and two factors. The first factor included six nitrogen concentrations, ground + iron addition sprayed on the plant (T1 0-0, T2 0-50 mg L^{-1}, T3 75 kg E^{-1} - 0, T4 75 kg E^{-1} - 50 mg L^{-1}, 150 T5 kg E^{-1} - 0 and 150 T6 kg E^{-1}-50 mg L^{-1}) Factor II Three levels represent concentrations of Acadian marine algae extract (A0 spraying with distilled water only and A1 Spraying with marine algae at level 1 ml L^{-1} and A2 level 2 ml l^{-1} spraying). The results showed that the T4 combination treatment was significantly superior to 75 kg E^{-1}-50 mg L^{-1} and gave the highest average protein concentration in seeds (18.33). The T6 combination treatment was significantly superior and gave the highest average total alkaloid content in seeds (3.52 mg 100 mg^{-1}) and total glycosides content in seeds(825.4 mg 100 g^{-1}) compared to the comparison treatment that gave the lowest averages. A1 marine algae spraying at 1 mL^{-1} level was significantly superior and gave the highest average protein concentration in seeds and total alkaloid and glycosides content in seeds (17.89%, 3.15 mg 100mg^{-1} and 823.9 mg 100 g^{-1} respectively compared to the comparison treatment that gave the lowest averages. A2 marine algae spraying at 2 ml^{-1} significantly outperformed and gave the highest average carbohydrate content in seeds (84.1 mg g^{-1}) compared to the comparison treatment. As for the intervention, it did not show any significant effect on the studied qualities.

Keywords: Fenugreek, marine algae extract ,Nitrogen ,Iron.

Introduction

Trigonellafoenum - graecum L. is an important and common plant in medical use since ancient times, and is widely used in most countries of the world as food and medicine because it contains many medically effective compounds [1], Fenugreek

leaves are an important food source and contain carbohydrates, protein, fats, minerals, fiber and many vitamins such as vitamin A, B1 and C [2] , As for its seeds, it is characterized by containing many important medicinal compounds such as alkaloids, carbohydrates, amino acids, soap steroids, flavons, etc [3].

It is necessary to pay attention to fertilizing medicinal and aromatic plants with the main nutrients that have an important role in improving growth qualities and that contribute to increasing production, the amount of economic yield and the content of medically active compounds, as studies have confirmed the importance of major nutrients for plants and their impact on vegetative growth qualities and the chemical content of the plant [4]. The importance of micronutrients is no less than macronutrients, despite the need of plants for them in smaller quantities and plays a vital role in various biological reactions and its importance lies in its direct and indirect impact on the activation of various enzymes, as iron plays an important role in activating the number of total enzymes and growth hormones, in addition to its role in oxidative and reduction processes [5].

Marine algae extracts, which have been used as a biostimulant for many physiological functions in plants, are rich in nutrients and are characterized by containing auxins and cytokinins, in addition to trace elements that have positive effects on cell growth and elongation, as well as yield, are considered a complement to fertilizers and not a substitute for them [6]. One of the extracts of marine algae (Acadian) is a rich source of main and secondary nutrients and carbohydrates that stimulate the productivity and quality of plants, enhance the production of enzymes, sugars and plant growth hormones, proteins and fats and increase the effectiveness of antioxidants. This study aims to: find out the effect of marine algae, nitrogen and iron on the medically active substances of fenugreek plant as well as determine the best treatment for the production of medically active compounds.

Materials and Methods

A field experiment was conducted in the field of experiments of Ibn Al-Bitar Vocational Preparatory School of the Directorate of Education in Holy Karbala, Department of Vocational Education during the winter season 2024-2023, to study the effect of marine algae, nitrogen and iron on some medically effective compounds of fenugreek plant seeds.The experiment was carried out with two factors. The first factor included six nitrogen concentrations, adding ground + iron sprayed on the plant (T1 0-0, T2 0-50 mg L^{-1}, T3 75 kg E^{-1}-0, T4 75 kg, E^{-1}- 50 mg L^{-1}, 150 T5 kg, E^{-1}-0, 150 T6 kg, E^{-1}-50 mg L^{-1}) The second factor is three levels representing the concentrations of Acadian marine algae extract (A0 spraying with distilled water only, A1 spraying with marine algae at the level of 1 ml l^{-1} and A2 Spraying with marine algae at the level of 2 ml l^{-1}) And with three repeats. The soil was plowed for agriculture by plowing, smoothing and leveling it, and then the land was divided into experimental units with an area of 6 m 2 (3 m ×2 m), and the seeds of the ring were planted Indian variety at a distance between

the line and the line of 50 cm and a distance of 20 cm between one plant and another and at a depth of 3 cm, and the harvest was plants at full maturity.

Protein concentration in seeds (%)

The percentage of protein was extracted by estimating nitrogen according to the following equation: Protein ratio = nitrogen ratio × 6.25 [7].

Carbohydrate content in seeds (mg g^{-1} dry weight)

Carbohydrate content in dry seeds was estimated according to[8].

Total alkaloid content in seeds (mg $100mg^{-1}$)

The total alkaloid content in the seeds was estimated according to[9].

Total glycosides content in seeds (mg $100g^{-1}$)

method using a UV-spectrophotometer. The glycosides content in seeds was quantified, according to the method described by [10].

Results and Discussion

Protein concentration in seeds (%)

The results of Table 1 The presence of a significant effect of the coefficients of nitrogen and iron syntheses added, as well as the presence of a significant effect of concentrations sprayed with marine algae extract acadian and the absence of a significant effect of the interference coefficients of adding nitrogen combinations + iron spraying and spraying plants with marine algae extract acadian in the protein concentration of fenugreek plant. The coefficients of adding combinations of nitrogen and iron show a significant effect in the concentration of protein in the seeds of fenugreek plants, as the T4 treatment significantly outperformed the rest of the coefficients and gave the highest average of (18.33)%, while the comparison treatment T1 gave the lowest average concentration of protein in the seeds amounted to (15.96%) with an increase of (14.85%).

The results showed a significant effect of spraying concentrations with marine algae extract on the protein concentration in the seeds, as the concentration of 1 g liter-1 gave the highest average protein concentration in the seeds of (17.89)%, while the non-addition treatment (comparison) gave the lowest average protein concentration in the seeds for the fenugreek plant amounted to (17.06)% with an increase of (4.87%). As for the intervention, it did not have a significant effect on the protein concentration of fenugreek plant.

Table (1): Effect of marine algae extract, nitrogen and iron and their interaction on the concentration of protein in seeds of fenugreek plant**.**

N Fe	Acadion			Mean
	0	1	2	
T1	16.31	16.47	15.11	15.96
T2	17.72	17.97	18.69	18.13
T3	16.66	18.55	18.28	17.83
T4	18.11	18.49	18.40	18.33
T5	16.55	18.59	17.77	17.63

T6	16.99	17.30	18.17	17.48
Mean	17.06	17.89	17.74	
L.S.D	**N Fe**	**Acadion**	**Acadion × N Fe**	
	1.444	**0.706**	**NS**	

Carbohydrate content in seeds (mg g^{-1} dry weight)

The results of Table 2 There is no significant effect of the added nitrogen and iron synthesis coefficients and the presence of a significant effect of spray concentrations with marine algae extract and no significant effect of the interference coefficients of adding nitrogen combinations + iron spraying and spraying plants with acadian marine algae extract in the carbohydrate content in the seeds of the fenugreek plant. The coefficients of adding combinations of nitrogen and iron showed no significant effect on the carbohydrate content in the seeds of fenugreek plants.The results indicated a significant effect of spraying concentrations with marine algae extract on the carbohydrate content in the seeds, as the concentration of 2 g liter-^{1} gave the highest average carbohydrate in the seeds amounted to (084.1) mg g-^{1}, while the non-addition treatment (comparison) gave the lowest average carbohydrate in the seeds for the fenugreek plant amounted to (64.40) mg g^{-1} with an increase rate of (30.59%). As for the intervention, it did not have a significant effect on the carbohydrate content in the seeds.

Table (2): Effect of marine algae extract, nitrogen and iron and their interaction on the carbohydrate content of seeds (mg g^{-1} dry weight) of fenugreek plant.

N Fe	Acadion			Mean
	0	1	2	
T1	45.80	67.20	72.00	61.70
T2	61.80	76.00	93.80	77.20
T3	72.00	96.90	94.50	87.80
T4	51.40	77.20	73.40	67.40
T5	68.70	75.00	81.30	75.00
T6	86.70	90.20	89.40	88.80
Mean	64.40	80.40	84.10	
L.S.D	N Fe	Acadion	Acadion × N Fe	
	NS	16.72	NS	

Total alkaloid content in seeds (mg 100mg^{-1})

The results of Table 3 The presence of a significant effect of the coefficients of nitrogen and iron syntheses added as well as the presence of a significant effect of concentrations sprayed with marine algae extract and the absence of a significant effect of the interference coefficients of adding nitrogen combinations + iron spraying and spraying plants with marine algae extract Acadian in the total alkaloid content of fenugreek plant, the coefficients of adding nitrogen and iron combinations showed a significant effect on the total alkaloid content of fenugreek plants, as the T6 treatment significantly outperformed the rest of the treatments and gave the highest average of

(3.521 mg 100 mg^{-1}, while The T1 comparison treatment gave the lowest average alkaloids of 2.797 mg 100 mg^{-1} with an increase of (25.88%).

The results showed a significant effect of spray concentrations with marine algae extract on the total alkaloid content, as the concentration of 1 g liter-1 gave the highest average total alkaloid content of (3.153) mg g^{-1}, while the non-addition treatment (comparison) gave the lowest average total alkaloids for fenugreek plant amounted to (2.808) mg g^{-1} with an increase rate of (12.29%). As for the intervention, it did not have a significant effect on the total alkaloid content of fenugreek plant.

Table (3): Effect of marine algae extract, nitrogen and iron and their interaction on total alkaloid content in seeds (100mg^{-1} mg) of fenugreek plant.

N Fe	Acadion			Mean
	0	1	2	
T1	2.520	2.900	2.970	2.797
T2	2.870	3.260	2.973	3.034
T3	2.800	2.900	3.068	2.923
T4	2.590	2.970	3.070	2.877
T5	2.840	3.105	3.070	3.005
T6	3.225	3.783	3.555	3.521
Mean	2.808	3.153	3.118	
L.S.D	N Fe	Acadion	Acadion × N Fe	
	0.3880	0.1925	NS	

Total glycosides content in seeds (mg 100g^{-1})

The results of 4 The presence of a significant effect of the coefficients of nitrogen and iron combinations added and the presence of a significant effect of concentrations sprayed with marine algae extract and the absence of a significant effect of the interference coefficients of adding nitrogen combinations + iron spraying and spraying plants with marine algae extract Acadian in the total glycosides content of fenugreek plant, as the coefficients of adding nitrogen and iron combinations indicate a significant effect in the glycoside content of fenugreek plants, as the T6 treatment significantly outperformed the rest of the treatments and gave the highest average of (825.40) mg 100 g^{-1}, while The comparison treatment T1 gave the lowest average of (799.40) mg 100 g^{-1} and an increase of (3.25%).

The results indicated a significant effect of concentrations sprayed with marine algae extract on the total glycosides content, as the concentration of 1 g L^{-1} gave the highest average total glycosides content of (823.90) mg 100 g^{-1}, while the non-addition treatment (comparison) gave the lowest average total glycosides for fenugreek plant amounted to (812.50) mg 100 g^{-1} with an increase of (1.40%). As for the intervention, it did not have a significant effect on the total glycosides ratio of fenugreek plant.

Table (4): Effect of marine algae extract, nitrogen and iron and their interaction on total glycosides content in seeds (mg $100g^{-1}$) of fenugreek plant**.**

N Fe	Acadion			Mean
	0	1	2	
T1	793.70	806.10	798.40	799.40
T2	819.40	829.30	823.90	824.20
T3	818.60	822.70	823.80	821.70
T4	801.30	831.20	825.60	819.37
T5	819.90	832.20	817.90	823.33
T6	821.80	822.10	832.30	825.40
Mean	812.45	823.93	820.32	
L.S.D	N Fe	Acadion	Acadion × N Fe	
	15.67	5.55	NS	

The results shown show a significant effect of the combinations of nitrogen and iron addition and the concentration of marine algae acadian in the medically active compounds of fenugreek plant.This may be due to the fact that nitrogen works to increase the production of secondary metabolic compounds and is a major source of manufacture of medically effective compounds in the plant and participates in the formation of a strong root system through which to improve the absorption of other nutrients from the soil and thus reflected in the increase in carbon metabolism [11]. This finding agrees with [12], that the use of nitrogen fertilizer positively affected the active compounds in the seeds of fenugreek plants .Nitrogen fertilization reflects positively on increasing some concentration of active substances found in medicinal plants [13].

As well as the role of iron in increasing active compounds due to the fact that it is an enzymatic companion of some of the biological reactions that occur within the plant, which in turn are by-products that enter into the formation of active compounds in medicinal plants [14].This finding is consistent with [15], that iron spraying treatments led to a significant increase in active ingredients in fenugreek plants.

As well as the role of marine algae extract because it contains major and minor nutrients, as it directly affected each of the basic components of protein, enzymes and hormones, and thus increase the rate of production and efficiency of the plant in the representation of nutrients when spraying on the vegetative system and thus occurs balance and homogeneity for these elements at the site of construction of carbohydrate and protein compounds and this contributes to improving the processes of vital metabolism and thus increasing the qualities of vegetative growth and yield and its components and qualitative qualities [16] .Studies have confirmed a positive effect of marine algae extract on medicinal plants [17, 18].

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