Response of some vegetative growth and yield traits by foliar nutrition with humic acid and the adding method of magnesium to mung bean crop (*Vigna radiata* L.)

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Abstract

A field experiment was conducted during the spring season of 2021 at Ibn Al-Bitar Vocational High School in Al-Hussainiya district / Holy Karbala province in order to determine the best concentration of humic acid and the best method of adding magnesium and their interaction in some traits of vegetative and yield growth of *vigna radiata* L. The experiment was conducted according to the design of randomized complete sectors, according to the order of the global experiments, with three replications, and the number of experimental units (36) experimental units.The results showed the following: Humic acid spraying treatment at a concentration of ($10gL^{-1}$) (H2) gave the highest averages in leaf area, chlorophyll content of leaves, spad, number of pods, weight of 100 seeds, seed yield and biological yield, which amounted to 379.6 cm^2, 52.13 spad, 85.63 pods.$plant^{-1}$, 5.76 g, 0.760 tons ha^{-1}, 36.64 tons ha^{-1}) respectively and the method of adding magnesium, where the method of ground addition and spraying (M1) with a concentration of 10 $g.L^{-1}$ and gave the highest averages in the number of pods and weight of 100 seeds, seed yield, and biological yield, as it reached (87.20 pods.$plant^{-1}$, 5.98 g, 0.783 tons.ha^{-1} , 3883 ton .ha^{-1}) respectively, we conclude through the study that the best concentration for spraying humic acid is 10 $g.L^{-1}$ with the addition of half the amount of spray and the ground addition of magnesium for its excelled in most of the traits of vegetative and yield growth of *Mung bean*.

key word: Seed yield, plant height, leaf area, humic acid, magnesium

Introduction:

The mung bean crop is one of the important leguminous crops, and its seeds are used as food for humans because they contain protein materials, as well as carbohydrates, oil and fiber. They are also used as feed for animals. Likewise, plants are used to improve the chemical and physical properties of soil, especially in newly reclaimed soils. mung bean grain contains 51% carbohydrates, 26% protein, vitamins 3%, and moisture 1% [4]. Humic acid is one of the most important acids that play an important role in the processes of oxidation, reduction, and carbonation [2]. Humic foliar fertilization leads to an increase in the plant's ability to retain water, photosynthesis, and photosynthesis antioxidants. and an increase in the leaf area index and the length of the main root, and humic contains a number of organic compounds that help in increasing the vegetative growth of the plant, increasing the yield and developing the root system [7]. Humic acid affects the growth and development of plants directly and indirectly. The direct effects include a change in the metabolic processes of the plant that occurs after the absorption of humic acid when these components enter the plant cell.There will be many changes in the cell membranes and the different components of the cytoplasm. Magnesium is one of the macronutrients for plants and is lost by washing. Magnesium has a necessary and important role in many vital plant activities, and it is a secondary and important nutrient element as it is one of the primary components of chlorophyll, and contributes to protein formation [9][16].The study aims to determine the best concentration of humic acid and the best way to add magnesium and their interaction in the characteristics of vegetative growth and yield of mung bean

Materials and methods

The field experiment was conducted during the spring season 2021 at Ibn Al-Bitar vocational high school located in Al-Hussainiya district of the Holy Karbala province to study the effect of foliar feeding with humic acid and the method of adding magnesium on the vegetative growth of mung bean and their interaction. Humic acid was sprayed with four concentrations (H0, H1, H2, H3) and the spraying was done during the stage of vegetative growth and flowering, and the methods of adding magnesium in the form of magnesium sulfate are as follows:

1- Adding ground and according to the recommended quantity (80 kg M ha^{-1})) (adding once at the beginning of planting) and symbolized by M0

2- Add half of the recommended ground amount and half the recommended spray amount (40 kg

M ha^{-1} and 10 ml L M^{-1}. Spraying during the vegetative growth stage) and symbolized by M1

3- Magnesium spray according to the recommended amount of 20 ml L^{-1}M. And in two batches (during vegetative and flowering growth) and symbolized by M2, and the experiment was implemented according to the Randomized Complete Block Design (RCBD) and according to the order of the global experiments, with three replications, and the number of experimental units is 36 experimental units.The planting was done on rows and the distance between one row and another was 0.50 m and between one pit and another 0.25 m and 3-4 seeds were placed in each pit at a depth of 2-3 cm. The soil was plowed by two orthogonal plows using a Moldboard plows and rotary disc harrows were used for smoothing and then the settlement process was completed, and phosphate fertilizer was added at an amount of 75 kg P_2O_5 ha^{-1} in the form of DAP(46% p2o5 and 18% N) when preparing [3]With the addition of nitrogen fertilizer at a rate of 40 kg H-1 in the form of urea (N46%), half of the amount when preparing the soil and the other half at the beginning of the emergence of sprouts. The physical and chemical properties of the soil were analyzed as shown in Table 1

Table (1) Some chemical and physical properties of the experimental field soil for the year 2021

unites	values	Elements
----------	7.78	pH
Dsm.$^{-1}$	2.4	electrical conductivity (EC)
mg.kg^{-1}	80.3	availability ammonium (NH4)
mg.kg^{-1}	27.5	availability Nitrate (NO3)
mg.kg^{-1}	17	phosphorous (P)
mg.L^{-1}	47.3	dissolved potassium (K)
%	0.8	Organic matter
----------	clay	soil texture

%	26	sand	Soil Separators
	13	silt	
	61	clay	

**The soil of the field was analyzed in the laboratory of the Directorate of Agriculture in the Holy Karbala province

The soil was cultivated with mash (local cultivar) on 1/3/2021

The spraying process was carried out in the early morning, and Al-Zahi was added to it as a surfactant in the amount of 1 ml liter per 1 liter of water.

studied traits

1- vegetative growth traits

1- leaf area (cm2):-

The triple leaf area was multiplied by the number of leaves per plant to calculate the total leaf area

2- leaves content of Chlorophyll (spad)

2- yield traits

1- The number of pods (1 pod of a plant):

-2 Weight of 100 seeds (g):

3- Seed yield (tons ha^{-1}):

4- Biological yield (ton ha^{-1}):

Statistical Analysis:-

The data were statistically analyzed for the experiment according to the randomized complete block design (R.C.B.D) using three replicates, the order of the factorial experiments, and using the statistical program (GenStat Vergin 2009), using the L.S.D least significant difference test at a probability level of 0.05 [4].

Results and Discussion

1- leaf area (cm^2):

The results in Table (2) indicate that there are significant differences in the method of adding magnesium and spraying humic acid and their interaction. The results indicate the method of spraying magnesium (M2) significantly excelled and gave the highest average amounted to (345.2) cm^2 While the method of ground

addition gave the lowest average amount (341.7 cm^2) and this is what was reached by [17] who indicated that the use of magnesium (50 ppm $MgSO_4$) foliar fertilization, has achieved an increase in the leaf area.It is noticeable from the results of the table that treatment (H2) was excelled and gave the highest average of (379.6 cm^2), while the control treatment (H0) gave the lowest average of (303.8 cm^2). The reason may be due to the role of humic acid in increasing the stomata absorption of nutrients It agrees with what was found by [8] who indicated that treating bean and cowpea plants with humic acid led to an increase in the leaf area. The results also indicate the existence of a significant interaction and gave the addition method (M1) with humic acid H2.It gave the highest mean of (385.0 cm^2), while treatment (M0) with control treatment (H0) gave the lowest average of (273.6 cm^2).

Table (2) Effect of humic acid concentrations and adding method of magnesium and their interaction on the leaf area of the plant (cm^2)

Adding method magnesium	Humic concentration $g.L^{-1}$				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	273.6	355.4	383.6	354.3	341.7
ground + Spraying ((M1 .)	303.8	366.7	385.0	314.7	342.6
Spraying (M2)	333.5	379.2	370.3	297.9	345.2
LSD 0.05	4.13				2.03
Humic average	303.6	367.1	379.6	322.3	
LSD 0.05	2.28				

2 - The chlorophyll content of the leaves:

The results in Table (2) indicate that there are no significant differences according to the method of adding magnesium and humic acid concentrations and their interaction where The addition method (M0) gave the highest average of (46.98 Spad), while the spraying method (M2) gave the lowest average of 46.64 Spad. The reason may be due to the main and most common function of magnesium in plants is its active role in increasing the percentage of chlorophyll in the leaves.It agrees with what was mentioned [10] to study the effect of different levels of magnesium (0,3.6) kg ha^{-1} Mgo and the excelled of the level (6 kg ha^{-1}) in increasing the content of chlorophyll spad in the leaves.The table results also indicate the excelled of the treatment (H2) and it gave the highest average of (52.13) Spad, while the control treatment (H0) gave the lowest average of (42.43) Spad. The reason may be due to the effect of humic acid on plant growth and development, directly and indirectly, and the positive correlation between the addition of humic and plant growth and development.The direct effects include a change in the metabolic processes of the plant that occurs after the absorption of humic acid. When these components enter the plant cell, many changes will occur in the cell membranes and the various components of the cytoplasm, which leads to an increase in the content of chlorophyll in the leaves.

He agreed with [20] and [8] who indicated that treating bean and cowpea plants with humic acid led to an increase in the chlorophyll content of the leaves.The results in Table (2) indicate that there is a significant interaction, as the addition method (M1) with treatment (H2) gave the highest average of (53.72) Spad, while the ground addition treatment with spraying (M1) and the control treatment without spraying (H0) gave the lowest average. reached (41.37)

Table (3) Effect of humic acid concentrations and the method of adding magnesium and their interaction on chlorophyll content of leaves.

Adding method magnesium	Humic concentration g.L $^{-1}$				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	41.43	46.18	49.85	50.44	46.98
ground + Spraying ((M1 .)	41.37	47.02	53.72	44.47	46.65
Spraying (M2)	44.50	48.03	52.83	41.20	46.64
LSD 0.05	2.27				n.s
Humic average	42.43	47.07	52.13	45.37	
LSD 0.05	1.31				

- Number of pods in a plant (pod .plant^{-1}):-

The results in Table (4) indicate that there are no significant differences according to the method of adding magnesium, and the presence of significant differences in the spraying of humic acid, and the presence of a significant interaction between the method of adding magnesium and humic.The results of the table noted that the concentration of (10 g L^{-1}) exceeded and gave the highest level of (85.63) pod .plant^{-1}, while the control treatment without spraying gave the lowest average of (64.51) pod .plant^{-1}.The reason may be that humic acid leads to an increase in the permeability of cell membranes, as humic acid directly affects cell membranes, increasing their permeability, which leads to ease of movement of nutrients to sites that require their presence.Also, humic acid changes the pattern of carbohydrate metabolism, leading to the accumulation of soluble sugars, which increases the osmotic pressure within the cell walls and makes the plant more resistant to drought, as well as increasing the ability of the plant's immune system [15].This leads to an increase in the yield components, including the number of seeds in the pod, and it is consistent with [6] a significant increase when spraying humic acid with concentrations (0, 0.5 and 1 g.L^{-1}) on the bean plant during the elongation stage in the average number of pods per plant.The results also indicate that there is a significant interaction, and the addition method (M1) gave the highest average of (87.20) pod .plant^{-1} while treatment (M0) with the control treatment (H0) gave the lowest average of (59.47) pod .plant^{-1}The reason is that adding the ground and spraying of magnesium to the plant increases the concentration of magnesium in the leaves, in addition to that magnesium represents

the center of the chlorophyll molecule, and this increases the process of photosynthesis, which in turn improves growth, flowering and set, and thus increases the number of pods in the plant It agrees with [19] in a field experiment that adding different levels of magnesium (0, 5, 10, 15) kg Mg. ha^{-1} on the strawberry crop and planted for the agricultural season (2007)Where the concentration of 5 kg Mg ha^{-1} resulted in a significant increase in the number of pods in the plant.

Table (4) The effect of humic acid concentrations and the method of adding magnesium and their interaction in the effect of Humic acid and magnesium concentrations in the number of pods (1 pod.plant^{-1})

Adding method magnesium	Humic concentration g.L $^{-1}$				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	59.47	74.33	83.53	77.87	73.80
ground + Spraying ((M1 .)	64.27	77.47	87.20	68.93	74.47
Spraying (M2)	69.80	80.40	85.33	60.27	73.95
LSD 0.05	3.58				n.s
Humic average	64.51	77.40	85.63	69.02	
LSD 0.05	2.07				

4- Weight of 100 seeds (g):

The results in Table (5) that there are no significant differences according to the method of adding magnesium, and the presence of significant differences in the spraying of humic acid, and the presence of a significant interaction between the method of adding magnesium and humic. The results of the table indicate the treatment (H2) excelled and it gave the highest level of (5.78) g, while the control treatment (H0) gave the lowest average of (4.59) g. The reason may be that humic acid changes the pattern of carbohydrate metabolism, leading to the accumulation of soluble sugars, which increases blood pressure. Osmosis within the cell walls makes the plant more resistant to drought, as well as increases the ability of the plant's immune system [15]This leads to an

increase in the yield components, including the number of seeds in the pod, and this corresponds to [6] a significant increase when spraying humic acid in concentrations (0, 0.5 and 1 ml. L^{-1}) on the broad bean plant during the elongation phase, where it gave the concentration (1 ml L^{-1}) highest average It is clear from the results that there is a significant interaction, and the method of addition (M1) excelled and gave the highest average of (5.98) g for the two seasons in succession, while the treatment of ground addition (M0) with the control treatment (H0) gave the lowest average of (4.12) g.The reason for the excelled is that the addition of magnesium has a role in increasing the absorption of phosphorous and its movement within the plant and also increases the plant's tolerance to drought [18] due to the speed of its movement within the plant, making proteins and forming chromosomes, as well as helping to transfer magnesium to the growing and active parts of the plant as there is A need for the formation of chlorophyll as well as the activation of the enzyme in the process of biogenesis of protein and building phloem by the effect of photosynthesis to ensure the growth of plant parts and this increases the weight of the seeds in the pod.It agrees with [19] in a field experiment that adding different levels of magnesium (0, 5, 10, 15) kg Mg. ha^{-1}on the mung bean crop grown for the agricultural season (2007), where the concentration of 5 kg Mg ha^{-1} resulted in a significant increase in the weight of (1000 seeds)

Table (5) The effect of humic acid concentrations and the method of adding magnesium and their interaction on the weight of 100 seeds (g)

Adding method magnesium	Humic concentration g.L $^{-1}$				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	4.12	5.31	5.66	5.20	5.07
ground + Spraying ((M1 .)	4.63	5.35	5.98	4.68	5.16
Spraying (M2)	5.03	5.60	5.70	4.26	5.15
LSD 0.05	0.27				n.s
Humic average	4.59	5.42	5.78	4.71	
LSD 0.05	0.07				

5

- Total seed yield (ton ha $^{-1}$):-

the results in Table (6) that there are no significant differences according to the method of adding magnesium, the presence of significant differences in the spraying of humic acid, and the presence of a significant interaction between the method of adding magnesium and humic. The results of the table also indicate the treatment (H2) and it gave the highest level of (0.760) tons ha^{-1}, while control treatment (H0) gave the lowest average of (0.561) tons ha^{-1}.The reason may be due to the fact that humic acid is a complementary source of polyphenols, which acts as a chemical and respiratory mediator, and this, in turn, leads to an increase in the biological activity of the plant, as the effectiveness of the enzyme system increases [14], as well as humic acid, increases the production of enzymes [12].This leads to an increase in the total seed yield and is consistent with [1] using three levels of humic acid foliar nutrition and concentration (0, 1, and 2 ml L^{-1}) in the growth of Broad bean plant (Vicia faba L. cultivar Luzde otono) and its production. The results showed the superiority of acid spray Humic at a concentration of (2ml.L $^{-1}$) as the total seed yield of the plant.It is noticed from the results that there is a significant interaction, and the treatment (M1) gave the highest average amounted to (0.783) tons ha^{-1}, while treatment (M0) with the control treatment (H0) gave the

lowest average amounted to (0.482) tons ha-1. The reason may be due to the addition of magnesium It plays an important role in the synthesis of chlorophyll, in addition to its main role in many physiological processes of the plant through its main function in the formation of the bark in addition to its importance in activating the work of some enzymes such as (AMP pyrohorylase, hexokinase, and Ghucokinase) and also affects the manufacture of proteins and the formation of chromosomes It also helps to increase the absorption of phosphorous and its movement within the plant and also increases the plant's tolerance to drought [18] due to the speed of its movement within the plant. It is possible to transfer magnesium to the growing and active parts of the plant, where there is a need for the formation of chlorophyll, as well as activating the enzyme in the process of biogenesis of protein and building phloem by the effect of photosynthesis to ensure the growth of plant parts and this increases the number of pods and the number of seeds per pod and the weight of 100 seeds and this leads to an increase in total seed yield. It agrees with [19] in a field experiment that adding different levels of magnesium (0, 5, 10, 15) kg Mg. ha^{-1} on the mung crop grown for the agricultural season (2007), where the concentration of 5 kg Mg ha^{-1} resulted in a significant increase in the number of seeds per pod, the number of pods, weight (1000 seeds), and the total seed yield.

Table (6) Effect of humic acid concentrations and the method of adding magnesium and their interaction on the total seed yield (ton ha^{-1})

Adding method magnesium	Humic concentration g.L^{-1}				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	0.482	0.680	0.781	0.634	0.644
ground + Spraying ((M1 .)	0.561	0.717	0.783	0.558	0.655
Spraying (M2)	0.642	0.745	0.715	0.489	0.648
LSD 0.05	0.04				n.s
Humic average	0.561	0.714	0.760	0.560	
LSD 0.05	0.02				

6- Biological yield (ton ha^{-1}):-

The results in Table (7) that there are no significant differences according to the method of adding magnesium, the presence of significant differences in the spraying of humic acid, and the presence of a significant interaction between the method of adding magnesium and humic. The results of the table indicate the superiority of treatment (H2) and it gave the highest level of (36.64) tons ha^{-1}, while the control treatment (H0) gave the lowest average of (19.51) tons ha^{-1}. The reason may be that humic acid works to increase cell division and the elongation of cells, humic acid improves the balance of cells, and the highest growth rate and the best conditions for cell division occur [13] and this increases the biological yield. This is consistent with [6] a significant increase when spraying humic acid with concentrations (0, 0.5, and 1 ml.L^{-1}) on the Broad bean plant during the elongation phase in the average plant height, number of leaves, dry weight, number of pods per plant, number of seeds per pod, pod weight and yield. Total seeds and this led to a significant increase in the biological yield. It is also clear from the results that there is a significant interaction, and the method of ground addition and spraying (M1) excelled and gave the highest average amounted to (38.83) tons ha-1, while the treatment of ground addition (M0) with the control treatment (H0) gave the lowest average of (17.68) tons ha^{-1} .The reason is due to a significant increase when spraying humic acid at a concentration (10 g .L^{-1}) (H2) with magnesium, which led to an increase in the characteristics of a number of leaves, dry weight, number of pods per plant, number of seeds per pod, pod weight and total seed yield, and this led to a significant increase in biological yield.It agrees with [11] during his study on the mung crop that foliar fertilization with magnesium led to a significant increase in the growth characteristics of the vegetative group and the biological yield of mung bean.

Table (7) Effect of humic acid concentrations and the method of adding magnesium and their interaction on the biological yield (tons ha^{-1})

Adding method magnesium	Humic concentration g.L $^{-1}$				magnesium Average
	0 H0	5 H1	10 H2	15 H3	
ground adding (M0)	17.68	23.48	37.16	27.77	26.52
ground + Spraying ((M1 .)	19.46	26.09	38.83	22.98	26.84
Spraying (M2)	21.39	30.23	33.93	20.87	26.60
LSD 0.05	2.60				n.s
Humic average	19.51	26.60	36.64	23.87	
LSD 0.05	1.50				

Conclusions:-

1- The foliar nutrition with humic acid spray showed a significant response in most of the studied traits of the mung bean crop when spraying with a concentration of ($10g.L^{-1}$) (H2).

2- The method of ground application and spraying (M1) of magnesium achieved a significant increase in growth traits, yield, and its components.

3- The method of ground addition of magnesium (M0) achieved a significant increase in the content of chlorophyll in the leaves of spad.

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