ARTICLE / INVESTIGACIÓN

Influence of humic and fulvic acid addition on soil N P K availability and broad bean output (*Vicia Faba* L.)

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Abstract: A field experiment was carried out during the agricultural season 2021-2022 at Al-Muthanna Governorate to study the effect of adding humic and fulvic acid in the soil on the availability of N P K in the soil, a simple RCBD experiment was designed with three replicates, it included the addition of a mixture of humic and fulvic acid (0, 5, 10 and 15) for L ha^{-1}. The results showed a significant superiority in increasing the concentration of availability NPK in the soil; the H2 treatment gave the highest rate of 204.00 and 32.76 mg kg $soil^{-1}$ for NK elements, respectively. The H3 treatment also showed the highest increase in the concentration of significant factors availability NPK in the soil after harvest; it reached 28.62, 14.30 and 155.00 mg kg $soil^{-1}$, respectively. The highest individual yield was 169.00 g $plant^{-1}$ when treated with H3, compared to the control treatment, which amounted to 134.80 g $plant^{-1}$.

Key words: Humic, Fulvic acids, Faba beans, NPK.

Introduction

Humic acids are a complex mixture of high molecular weight; it contains some water-soluble substances, such as amino acids and a percentage of plant metabolism products. Humic acids are the essence of organic matter and the active and vital part, which was characterized by the amorphous colloidal nature[1].

The addition of humic acid and fulvic acid to the soil leads to the formation of natural chelates and contributes to the liberation of many elements from soil minerals and their chelation in the root system area, liberation from minerals increases by the increase of organic acids that are added to the soil, in addition, it improves the chemical, physical and biological properties of the soil. Organic acids encourage plant growth because they are carbon compounds that build plant tissues[2,3].

Adding organic fertilizers containing humic and fulvic acid to the soil improves its physical, chemical and biological properties. It maintains soil moisture, helps supply the soil with some nutrients, and increases the activity of microorganisms, including the root nodules bacteria that have a symbiotic relationship with legumes, which can fix atmospheric nitrogen biologically. The importance of nitrogen lies in the survival and development of plants throughout the vegetative growth period. Most organisms do not use this vital source of nitrogen except for some bacteria[4].

Organic acids have no adverse effects on the environment, as the positive effects of humic acid on growth increase the effectiveness of soil microorganisms. As well as increasing the area of contact between the root hairs of the plant host and rhizobia bacteria and root development, humic acid improves biological nitrogen fixation in legumes, and humic acid is a rich source of nitrogen, phosphorous and some other elements[5].

The importance of providing availability of nutrients for absorption by the plant in the soil and humic and fulvic acid effect. This study was conducted to show the effect of humic and fulvic acids on the availability of NPK in the soil and in the number and weight of root nodules and its reflection on the yield of the plant.

Materials and methods

A field experiment was carried out in Al-Jurf area, located in Al-Rumaitha district, 43 km north of Al-Samawa city, the center of Al-Muthanna Governorate, during the winter agricultural season 2021-2022, at clay loam soils Table 1.

The land was plowed twice perpendicularly, then smoothed by the disc combs, then divide the field manually into three blocks, 16 experimental units for each; the furrow was 2 meters long, furrow contained 10 holes, the distance between the holes is 20 cm and a depth of 5 cm [6], Grano Violetto faba bean cultivar was planting, by 4 seeds in each hole on 12/11/2021. Thinning operations were carried out as the plants were thinned to one plant for each hole when two true leaves appeared. Irrigation and manual weeding were carried out in all transactions whenever needed. Mono superphosphate fertilizer (22% P2O5) was added at 80 kg ha^{-1} before planting, and potassium sulfate fertilizer (42% K)[7] was added at a rate of 80 kg ha^{-1}.

The study included adding a mixture of humic and fulvic acid (Table 2) on the ground, with four levels (0, 5, 10, 15) liters ha^{-1}, they were denoted by H0, H1, H2 and H3 respectively, an experiment was carried out according to a Randomized Complete Block Design with three replicates, were randomly distributed. The data were analyzed using

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Item	Value	Unit
pH	7.10	---
EC	3.30	dS m^{-1}
Organic Mater	1.54	g kg^{-1} soil
Available nitrogen	20.00	mg kg^{-1} soil
Available phosphorus	15.31	
Available potassium	102.02	
Soil type		
Sand	272.00	g kg^{-1} soil
Silt	420.00	
Clay	308.00	
Soil Texture	Clay loam	

*The analyses were conducted in the central laboratory of the Soil and Water Department, College of Agriculture, University of Baghdad.

Table 1. Some physical and chemical properties of the experimental field soil before planting.

Items	Values	Unit
Humic acid	80.00	%
Fulvic acid	3.40	%
Organic matter	14.00	%
Potassium(K2O)	0.60	%
Iron	0.30	%
Density	1.12	Kg L^{-1}

Table 2. Components of fertilizer containing humic and fulvic acid.

the statistical program Genstsat; after collecting data from the field and tabulating it in Excel, means were compared using the LSD test at a 0.05 probability level.

NPK was estimated in the soil at flowering after harvest; soil samples were taken from 0.30 cm depths at the flowering and harvest stages.

The availability of nitrogen was estimated using the Kjeldahl apparatus, the availability of phosphorus by spectrophotometer has a wavelength of 882 nanometers, availability of potassium by the flame photometer, according to it[8].

Results

Soil Content of availability NPK at Flowering (mg kg^{-1} soil)

Table 3 shows that soil additions to humic and fulvic acid significantly affected the concentration of NPK elements in the soil during flowering. The H2 treatment gave the highest rates of N K, which amounted to 204.00 and 32.76 mg kg^{-1} soil, respectively. In contrast, the H3 treatment showed the highest mean of availability P in the soil at flowering (20.00) mg kg^{-1} soil, compared to the comparison treatment H0, which gave the lowest rates, it was (24.24, 18.38, 139.40) mg kg^{-1} soil sequentially, H2 treatment achieved the highest percentage of increase of availability N in the soil at flowering, as it reached 35.15%. H3 recorded the highest rise of PK availability on the ground, which amounted to 8.81 and 46.34 %.

Soil Content of Availability NPK After harvest (mg kg^{-1} soil)

Table 4 shows that the ground addition of a mixture of humic and fulvic acid was a significantly affected the concentration of NPK in the soil after harvest, H3 gave the highest mean of the components of N and P availability in the soil, which amounted to 28.62 and 14.30 mg kg^{-1} soil, respectively, compared to the comparison treatment H0, which gave the lowest averages, which amounted to 13.79 and 13.02 mg kg^{-1} soil, sequentially, H2 treatment gave the highest mean of availability K (156.40) mg kg^{-1} soil, it did not differ significantly from the level of H2, which outperformed the control treatment, which amounted to 128.80 mg kg^{-1} soil, the soil additions recorded percentages more than the comparison level, H3 treatment recorded the highest increase rates availability of N and P in the soil after harvest amounting to 107.54 and 9.83 %, respectively, for the two components of N and P, H2 treatment had an effect on the percentage increase, which amounted to 21.43% compare with H0 level, all levels of addition were significantly superior to the availability N, P and K concentration except for the H1 level, it was not significantly superior to the comparison level in the percentage of P in the soil, whereas, the level of H2 was significantly superior to the treatment of H3 in terms of K in the soil.

Tables 3 and 4 showed that the treatment of soil addition of humic acids was significantly superior in all the studied traits, leading to an increase in (the percentage of nitrogen, phosphorous and potassium in the soil); this result is consistent with what was stated in the study[9]. The percentage of KPN increases by adding humic acid, possibly because humic acids contain a good concentration of major nutrients. The increase in KPN may be due to adding humic acids to the soil in lowering the pH of the solution, increasing the cation exchange capacity and improving soil properties, thus increasing its availability in the soil.

Traits	Treatments				L.S.D$_{0.05}$
	H$_0$	H$_1$	H$_2$	H$_3$	
Available N (mg kg^{-1} soil)	24.24	30.24	32.76	32.10	2.13
Available P (mg kg^{-1} soil)	18.38	19.35	19.76	20.00	0.81
Available K (mg kg^{-1} soil)	139.40	160.10	204.00	196.00	7.20

Table 3. Effect of adding humic and fulvic acid on the concentration of NPK in soil at flowering stage (mg kg-1 soil).

Traits	Treatments				L.S.D$_{0.05}$
	H$_0$	H$_1$	H$_2$	H$_3$	
Available N (mg kg^{-1} soil)	13.79	19.04	24.82	28.62	2.34
Available P (mg kg^{-1} soil)	13.02	13.23	13.96	14.30	0.30
Available K (mg kg^{-1} soil)	128.80	143.20	156.40	155.00	5.81

Table 4. Effect of adding humic and fulvic acid on the concentration of NPK in the soil after harvest (mg kg-1 soil).

Weight of individual yield (g plant-1)

Table 5 shows that the yield of bean plants increased significantly when humic and fulvic acid was added to the soil compared to the control treatment; the levels of soil addition treatments of acids H3, H2 and H1 gave averages of 166.40, 148.30 and 169.00 g plant^{-1}, respectively, while the comparison treatment H0 gave the lowest value of 134.80 g plant^{-1}. The soil addition also led to an increase in the yield of 23.44, 10.01 and 25.37%, compared to the comparison treatment, it was also noted that all levels of treatments were significantly superior to the comparison treatment except for the H1 treatment, which was significantly superior to the level of addition H2.

Discussion

The results showed that the treatment of soil addition of humic acids was significantly superior in all the studied traits and led to an increase in (the percentage of nitrogen, phosphorous and potassium in the soil); this result is consistent with what was stated in the study[9,10]. Mentioned that commercial humic acid was an organic mineral fertilizer, increases soil fertility and increases the availability of the elements, and then plant growth and yield. Regarding nitrogen, humic acids contain a high level of ready carbon, which is a good food source for microorganisms, including Rhizobia bacteria, which gives it good growth, thus, biological nitrogen fixation, which contributes to increasing the soil stock of available nitrogen, as well as increasing the vitality of reviving the microscopic soil in conjunction with the activity of the root mass, makes it more secretion of degrading enzymes and compounds, that contribute to the increase of soil humus, it will be an important factor in facilitating some soil-fixed or unfavorable elements such as phosphorous and potassium, it was characterized by what is easy and available in the soil solution[11].

The addition of humic and fulvic acid has a direct effect on the preparation of the element and phosphorous for soil and plants due to the adsorption of phosphate anions by the amino group present in these acids and the improvement of their availability for the plant, improving the availability of phosphorous in different soil reaction degrees[10], this was consistent with[12]. Adding or spraying organic acids to the soil or plant leads to an increase in vegetative growth, which was accompanied by an increase in the products of photosynthesis, to encourage root growth and increase root mass, which may be the reason for the increase in the weight of the bacterial nodules. (11) indicated that there was a direct relationship between the products of photosynthesis and the increase in the weight of bacterial nodules and their effectiveness in leguminous plants, this was explained by the increase in the number of installed units of carbon dioxide in the photosynthesis process, accompanied by an increase in the weight of the bacterial nodule, as well as an increase in the percentage of biologically proven nitrogen belonging to the plant, it was used in the manufacture of various compounds, which nitrogen is included in its composition, and this is consistent with what was reached[13].

With regard to the individual yield, the results showed that the addition of soil humic and fulvic acid had a significant effect on the characteristic of the yield. The increase may be attributed to the role of humic acids in improving vegetative growth, reducing food competition between pods and thus increasing the yield components (number of pods, number of seeds in a pod), or the reason may be attributed to the positive effect of humic acids, that encourages the absorption of nutrients, stimulation of enzymatic reactions and

Traits	Treatments				L.S.D$_{0.05}$
	H$_0$	H$_1$	H$_2$	H$_3$	
Individual yield (g plant^{-1})	134.80	166.40	148.30	169.00	13.45

Table 5. Effect of adding humic and fulvic acid on the yield of individual plants of the bean plant.

activation of biological processes, this has a great role in the representation of carbohydrates and protein within the plant and its transfer to the rest of the parts, including the pods[4], agreed with (15). Usually the components of good yield are directly related to the increase in indicators of good vegetative growth, the addition of humic acid improved the vegetative growth, by the activation of vital processes and the consequent increase in nitrogen absorption and increase in the number and fullness of the pods, which indicates a good metabolism in the leaves and the transfer of these products to the seeds, or, the reason may be that humic acids contain amino acids or proteins. The plant benefits directly from it, and this is reflected in the increase in the weight of the seeds[16], this result was consistent with the findings of (17-20).

We conclude from the previous results a significant response to the addition of a mixture of humic and fulvic acid on the availability of NPK in soil, on its biological properties, especially at the concentration of 15 liters ha^{-1}, this explains the role of the active humic acid addition, on increasing the availability of major nutrients and biological activity in the soil[21].

Conclusions

The results showed a significant superiority in increasing the concentration of availability NPK in the soil, the H2 treatment gave the highest rate of 204.00 and 32.76 mg kg soil-1 for NK elements, respectively. The H3 treatment also gave the highest increase in the concentration of major elements availability NPK in the soil after harvest, it reached 28.62, 14.30 and 155.00 mg kg soil-1, respectively . the highest individual yield was 169.00 g plant-1 when treated H3, compared to the control treatment, which amounted to 134.80 g plant-1.

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