Effect of sulfur and foliar application of organic fertilizers on growth, yield and quality of garlic

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Abstract

The field experiment was conducted during the season 2021-2022 in Baquba nursery affiliated to Diyala Agriculture Directorate.In order to study the effect of organic fertilizer and agricultural sulfur on the growth and yield of garlic, the study included two factors; The first is sulfur: control, agricultural sulfur, ground addition 75 kg ha^{-1}, and spraying with liquid sulfur 2 ml L^{-1},The second factor was spraying with five types of organic fertilizers, namely: spraying with aqueous extract of sheep manure at a concentration of 100%, spraying with polyamine at a concentration of 2 g L^{-1}, spraying with humic acid 1 ml L^{-1}, and spraying with compost tea at a concentration of 100% in addition to a control treatment .The experiment included fifteen treatments and three replications, The results showed that spraying with liquid sulfur 2 ml L^{-1} (the superiority) of all urban growth traits represented by the plant height and the percentage of dry matter in green leaves compared to the control treatment. As well as the excelled in the traits of the yield and represented by the diameter of the head, Head weight, for the total yield of heads compared to the control treatment. in order and the qualitative traits represented by the percentage of protein, nitrogen and phosphorous and potassium compared to the control treatment. As for spraying with organic fertilizers, the results showed that there was a significantly excelled of spraying with humic acid 1 ml L^{-1} in plant height and the percentage of dry matter in green leaves compared to the control treatment. As well as the excelled in the yield traits represented by the diameter of the head, head weight, the total yield of heads compared to the control treatment .It was also excelled in the qualitative traits represented by the percentage of protein, nitrogen, phosphorous and potassium compared to the control treatment.

Introduction

Garlic, *Allium sativum* L. is a herbaceous biennial plant that is widely cultivated in most parts of the world. It is the second most cultivated species in the vegetable crops of Alliaceae family , after onions, which are widely cultivated in the world (9). As garlic is grown in Iraq as a winter crop, garlic cloves are considered to be of high nutritional and medicinal value. Garlic also contains organic sulfur compounds, amino acids, steroids sugars, flavonoids, phenols and vitamins, in addition to other elements such as phosphorous, potassium, iron and selenium and germanium and ascorbic acid, and that the effective effect of sulfur compounds comes through the consumption of fresh garlic, as the heat negatively affects the effectiveness of garlic and its ability to eliminate fungi, infections, cancer and some heart diseases. It is also used as an antiseptic and to reduce high blood pressure (13). Garlic also contains a distinctive compound produced by the mechanism, Allicin, which is the main compound from which sulfur compounds are formed. It also shows an antimicrobial effect. In addition, it is responsible for the medicinal and therapeutic properties of garlic (15). Sulfur is characterized by its important role in

plant nutrition through the addition to the soil or spraying on the plant. Sulfur is an important factor in plant growth, as it enters the protein composition through the formation of many amino acids Cystine, cysteine and methionine, which are important amino acids in building protein, and sulfur has A major effect in stimulating the metabolism process and glutathione is necessary for the synthesis of chlorophyll and vitamins (16).

The nutrients balance the soil and fulfil the necessary needs of plant nutrient elements throughout the growth phases. It even decreases the intensive demand for mineral fertilizers, Diminishes the licking of nutrient elements forms)7),(18)The importance of foliar application ~~spraying~~ of organic nutrients in plant nutrition is highlighted because they contain a wide range of water-soluble organic compounds such as sugars, amino acids, proteins, humic and humic organic acids, as these compounds participate directly or indirectly in plant growth, or they are encouraging growth by Enzymatic or hormonal, it also contains the nutrients needed by the plant so as to improve growth and increase production (2). (3) concluded that spraying liquid sulfur on onion plants at a concentration of 2 ml L^{-1} gave significant excelled in plant height, leaf dry weight, leaf length, bulb diameter, bulb weight and total yield. (12) found that spraying liquid sulfur on an onion plant at a concentration of 3 ml L-1 increased the percentage of nitrogen, phosphorous and potassium. ~~(12) found that spraying liquid sulfur on an onion plant at a concentration of 3 ml L^{-1} led to an increase in the percentage of nitrogen, phosphorous and potassium.~~ and the total result, (1); (8) also indicated that the use of humic acid to be sprayed on the plant led to an increase in plant height, head diameter and head weight. (19) noted that the use of humic led to an increase in the percentage of nitrogen, phosphorous and potassium. Based on an advanced study, this experiment aimed to study the effect of organic fertilizer and sulfur on the growth and yield of garlic (20)، also indicated that the use of humic acid to be sprayed on the plant led to an increase in plant height, head weight and total yield.

Materials and methods

The experiment was conducted in ~~the field of~~ Baquba Nursery - Plant Production Department - Diyala Agriculture Directorate during the 2021-2022 agricultural season. The field designated for cultivation was prepared and prepared, starting with removing the weeds, tillage, smoothing and leveling it and dividing it into longitudinal terraces, the width of the terrace is 75 cm and its length is 1.5 m, and the distance between one terrace and another is 50 cm. The experiment included 6 terraces, and each two terraces represented one replicates, each replicates included 15 experimental units, each of which had an area of 3 m^2. The planting was on 1/11/2021 and the distance between one plant and another was 12 cm and alternately.

The study included two factors:

The first factor: sulfur fertilization

1- The control treatment is spraying with water only

2- Agricultural sulfur ground additive 75 kg ha^{-1}

3- Liquid sulfur (Zolfast 83%) at a concentration of 2 ml L^{-1} spraying on the plant

The second factor: organic fertilizers from different sources

1- The control treatment is spraying with water only

2- Aqueous extract of sheep waste with a concentration of 100%

3- Polyamine at a concentration of 2 g L^{-1}

4- Humic acid at a concentration of 1 ml L^{-1}

5- 100% compost tea

The experiment was conducted using a complete randomized block design (RCBD)

and a split-plot design. The sulfur fertilization treatments were randomly distributed in the main plots and the organic fertilizers sprayed in subplots were also distributed randomly. The number of sulfur fertilization treatments 3 * the number of spraying treatments with organic fertilizers 5 = 15 treatments in each replicate, meaning that each sector contains 15 experimental units and three replicates, so the number of experimental units is 45 units, and each unit includes 90 plants. The averages were compared according to Duncan's polynomial test at a probability level of 0.05 (6).Agricultural sulfur was added and mixed with the soil at a depth of 20 cm while dividing the field. As for liquid sulfur, it was sprayed five times on the plant, and organic fertilizers were used as a spraying on the plant five times. The study indicators included plant height, percentage of dry matter in green leaves, head diameter, head weight, total yield of heads, nitrogen, phosphorous, potassium and protein percentage. The nitrogen element was estimated by the process of evaporation and distillation mediated by the Kjeldahl-Micro device. As for phosphorous, it was estimated by a spectrophotometer at a wavelength of 882 nm, and a flame photometer estimated potassium.

Results and discussion

Plant Height (cm):

The results in Table 1 show that there was a significant effect of sulfur on plant height, where both treatments gave agricultural sulfur, ground addition and liquid sulfur spraying, the highest plant heights of 106.13 cm and 108.28 cm, respectively, while the control treatment gave the lowest plant height of 102.34 cm. The same table also shows a significant differences between the spraying with organic fertilizers, where spraying with humic acid gave the highest plant height of 112.77 cm. It was followed by the polyamine spray treatment, which amounted to 110.20 cm, while the control treatment gave the lowest plant height of 91.04 cm. The interaction between sulfur and spraying with organic fertilizers had a significant effect on the plant height, as the interaction between liquid sulfur and humic acid gave the highest plant height of 115.60 cm, while the comparison treatment gave the lowest plant height of 88.93 cm.

Table 1. Effect of spraying with organic fertilizers and methods of adding sulfur and the interaction between them on garlic plant height (cm)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
91.04 D	92.20 ^{f}	92.00 ^{g}	88.93^{g}	**without spraying (control)**
109.12 B	111.90 ^{abc}	109.86 ^{bcde}	105.60 ^{def}	**sheep manure extract**
110.20 AB	113.26 ^{ab}	110.60 ^{abcd}	106.73 ^{cde}	**polyamine**
112.77 A	115.60 ^{a}	113.06 ^{ab}	109.66 ^{bcde}	**Humic**
104.80 C	108.46 ^{bcde}	105.13 ^{ef}	100.80 ^{f}	**Compost tea**
	108.28 A	106.13 AB	102.34B	**sulfur average**

*Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Dry matter percentage of green leaves (%):

The results in Table 2 show that sulfur had a significant effect on increasing the dry matter percentage in green leaves, as agricultural sulfur excelled over ground addition and liquid sulfur and gave the highest percentage amounting to 16.91% and 17.65%, respectively, while the comparison treatment gave the lowest percentage of 14.83%. The results in Table 2 also show that there is a significant difference between the treatments of spraying with organic fertilizers, it excelled on spraying with humic acid and gave the highest percentage of dry matter amounted to 18.58%, followed by the polyamine treatment, which amounted to 17.47%, followed by the treatment of spraying with aqueous extract of sheep waste and amounted to 16.83%, while the control treatment decreased and gave the lowest The percentage amounted to 13.34%. The interaction effect between sulfur and spraying with organic fertilizers was significant, as plants sprayed with liquid sulfur and humic acid excelled and gave the highest percentage of dry matter amounted to 20.65%, while the control treatment (not fertilized with sulfur and without organic fertilizer spraying) was lower, and the lowest percentage was recorded at 12.91%.

Table 2. Effect of spraying with organic fertilizers and methods of adding sulfur and the interaction between them on the percentage of dry matter in green leaves of garlic (%)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
13.34 D	13.82 igk	13.29 gk	12.91 k	without spraying (control)
16.83 BC	17.81 bcde	17.60 cde	15.08 hig	sheep manure extract
17.47 B	18.79 bc	18.02 bcd	15.60 gh	polyamine
18.58 A	20.65 a	19.17 b	15.92 fgh	Humic
16.10 C	17.17 def	16.45 efg	14.67 igh	Compost tea
	17.65 A	16.91 A	14.83 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Head diameter (mm):

The results in Table 3 showed a significant effect of sulfur on head diameter. Liquid sulfur was distinguished by giving the largest diameter of 59.68 mm, while the control treatment recorded the lowest head diameter, which was 53.46 mm. The results also showed in the same table that there are significant differences between the treatments of spraying with organic fertilizers, the treatment of humic acid with the highest diameter was 62.59 mm, followed by the polyamine treatment, which amounted to 60.59 mm, followed by the treatment of aqueous extract of sheep manure reached 58.28 mm, while the control treatment decreased and gave the lowest diameter of

which reached 48.65 mm. As for the effect of the interaction between sulfur and spraying with organic fertilizers, it had a significant effect on trait of the head diameter, as the plants sprayed with liquid sulfur and humic gave the largest head diameter of 66.33 mm, while the control treatment gave the lowest diameter of 46.68 mm.

Table 3. Effect of organic fertilizers and methods of adding sulfur and the interaction between them on the head diameter of garlic plants (mm)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
48.65 E	49.77 ^{h}	49.52 ^{h}	46.68 ^{i}	without spraying (control)
58.28 C	60.67 ^{cd}	58.75 ^{de}	55.44 ^{f}	sheep manure extract
60.59 B	63.75 ^{b}	62.47 ^{bc}	55.54 ^{f}	polyamine
62.59 A	66.33 ^{a}	64.36 ^{ab}	57.07 ^{ef}	Humic
55.47 D	57.87 ^{ef}	55.96 ^{f}	52.57 ^{g}	Compost tea
	59.68 A	58.21 B	53.46 C	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Head weight (head g^{-1}).

The results obtained from Table 4 indicate a significant effect of sulfur on the weight of one head, as ground and liquid sulfur were distinguished by giving the highest head weight of 70.68 and 75.27 g, respectively, while the comparison treatment was low by giving the lowest head weight of 59.25 g. The results of the same table show significant differences between the treatments of spraying with organic fertilizers, where spraying with humic acid excelled with the highest head weight of 81.33 g, followed by the treatment of spraying with a polyamine, , which amounted to 75.47 g. Then the treatment of spraying with aqueous extract of sheep waste amounted to 71.80 g, while the control treatment decreased and gave the lowest head weight of 50.03 g. The interaction between sulfur and spraying with organic fertilizers had a significant effect on head weight, as the plants sprayed with liquid sulfur and humic acid were distinguished by giving the highest head weight of 92.55 g, while the control treatment (non-fertilized with sulfur and without organic fertilizer spraying) gave the lowest weight of 48.33 g.

Table 4. Effect of organic fertilizers and methods of adding sulfur and their interaction on the head weight of garlic plants (g)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
50.03 D	52.11 ^{gh}	49.66 ^{h}	48.33 ^{h}	without spraying (control)
71.80 B	79.44^{bc}	74.10 ^{cd}	61.86 ^{ef}	sheep manure extract
75.47 B	83.70^{b}	81.00 ^{bc}	62.53 ^{ef}	polyamine
81.33 A	92.55^{a}	85.44 ^{b}	66.00 ^{e}	Humic
63.11 C	68.56^{de}	63.22 ^{ef}	57.55 ^{fg}	Compost tea
	75.27 A	70.68 A	59.25 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Total head yield (tons ha^{-1}).

The results in Table 5 show that sulfur produced a significant improvement in the total yield of the heads, as liquid sulfur gave the highest yield of 22.58 tons ha^{-1}, while treatment without addition gave the lowest yield of 17.77 tons ha^{-1}.Also, Table 5 showed that there were significant differences between the treatments of spraying with organic fertilizers, as the treatment of spraying with humic acid gave the highest yield, which amounted to 24.39 tons ha^{-1}, followed by the treatment of spraying with polyamine, which amounted to 22.72 tons ha^{-1}.Followed by spraying with aqueous extract of sheep waste amounted to 21.54 tons ha^{-1}, while the control treatment decreased and gave the lowest yield of 15.01 tons ha-1.The table also indicated that there is a significantly excelled in the interaction between sulfur and spraying with organic fertilizers in the total yield of heads. The interaction treatment between spraying with liquid sulfur and spraying with humic acid gave the highest significant value of heads amounted to 27.76 tons ha^{-1}, while the control treatment gave the lowest value amounting to 14.50 tons ha^{-1}.

Table 5. Effect of organic fertilizers and methods of adding sulfur and the interaction between them on the total yield of heads (ton ha^{-1})

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
15.01 D	15.63 ^{gh}	14.90 ^{h}	14.50 ^{h}	without spraying (control)
21.54 B	23.83 ^{bc}	22.23 ^{cd}	18.56 ^{ef}	sheep manure extract
22.72 B	25.11 ^{b}	24.30 ^{bc}	18.76 ^{ef}	polyamine
24.39 A	27.76 ^{a}	25.63^{ab}	19.80 ^{e}	Humic
18.93 C	20.56 ^{de}	18.96 ^{ef}	17.62 ^{gf}	Compost tea
	22.58 A	21.20 A	17.77 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Leaves nitrogen content (%):

The results in Table 6 show that sulfur was significant in increasing the nitrogen content in the leaves, where agricultural sulfur excelled on the ground addition and liquid sulfur and gave the highest nitrogen content of 2.75 and 2.91%, respectively, while the control treatment gave the lowest percentage of 2.15%.The results also show in the table below ~~that there is~~ a significant difference between sulfur treatments~~the treatments of sulfur~~ and spraying with organic fertilizers. Humic acid excelled and gave a significant increase in the nitrogen ratio, which amounted to 3.31%, followed by the polyamine treatment, without a significant difference, which amounted to 3.08%, followed by the treatment of the aqueous extract of sheep waste, which amounted to 2.64%. While the control treatment gave the lowest percentage of 1.49%.The interaction effect between sulfur and spraying with organic fertilizers was significant, as the interaction treatment between liquid sulfur and humic acid was superior and gave the highest nitrogen percentage of 3.78%, while the control treatments recorded the lowest nitrogen percentage of 1.40%.

Phosphorous percentage in leaves (%)

The results in Table 7 showed that sulfur was significant in increasing the percentage of phosphorous in the leaves, as liquid sulfur excelled and gave the highest percentage of phosphorous, which amounted to 0.33%, while the comparison treatment decreased and gave the lowest percentage, which amounted to 0.28%.The results also showed in the same table that there was a significant difference between the treatments of spraying with organic fertilizers, where humic acid excelled and gave the highest significant increase in the percentage of phosphorous, which amounted to 0.37%, followed by the polyamine treatment, which amounted to 0.33%, while the control treatment gave the lowest percentage, which amounted to 0.22%. The interaction effect between sulfur and spraying with organic fertilizers was significant, where the interaction treatment between liquid sulfur and humic acid was excelled and gave the highest phosphorous ratio of 0.41%, while the

control treatments recorded the lowest phosphorous ratio of 0.22%.

Table 6. Effect of spraying with organic fertilizers and methods of adding sulfur and their interaction on nitrogen content in garlic leaves (%)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
1.49C	1.53 ^{gh}	1.55 ^{gh}	1.40 ^{h}	without spraying (control)
2.64B	2.96 ^{bcd}	2.83 ^{bcd}	2.14 ^{efg}	sheep manure extract
3.08A	3.40 ^{ab}	3.30 ^{abc}	2.53 ^{def}	polyamine
3.31A	3.78 ^{a}	3.47 ^{ab}	2.68 ^{cde}	Humic
2.50B	2.89 ^{bcd}	2.62 ^{def}	2.00 ^{fgh}	Compost tea
	2.91 A	2.75 A	2.15 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Table 7. Effect of spraying with organic fertilizers and methods of adding sulfur and the interaction between them on the percentage of phosphorous in garlic leaves (%):

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
0.22 E	0.23 ^{h}	0.22 ^{h}	0.22 ^{h}	without spraying (control)
0.31 C	0.33 ^{cde}	0.31 ^{def}	0.29 ^{fg}	sheep manure extract
0.33B	0.36 ^{bc}	0.34 ^{cd}	0.30 ^{ef}	polyamine
0.37A	0.41 ^{a}	0.38 ^{ab}	0.32 ^{de}	Humic
0.29D	0.31 ^{def}	0.30 ^{efg}	0.27^{g}	Compost tea
	0.33 A	0.31 B	0.28 C	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

Potassium content in leaves (%):

The results in Table 8 indicate that there are significant differences in the percentage of potassium in the leaves when using sulfur, where agricultural sulfur excelled on the ground addition and liquid sulfur and gave the highest percentage of potassium amounting to 3.02% and 3.16%, respectively, compared to the control treatment, which gave the lowest percentage of 2.65% . The results in the same table showed that there was a significant difference between the treatments of spraying with organic fertilizers, whereas agricultural sulfur excelled in the ground addition and liquid sulfur and gave the highest percentage of potassium, amounting to 3.02% and 3.16%, followed by the polyamine treatment of 3.26%, followed by the treatment of aqueous extract of sheep waste 3.05%, while the control treatment decreased and gave the lowest percentage, which reached 1.88%. The table below showed that there were significant differences between the interaction treatments between sulfur and spraying with organic fertilizers, where the interaction treatment between liquid sulfur and humic acid was superior and gave the highest potassium percentage amounting to 4.13% compared to the control treatment which gave the lowest percentage amounting to 1.71%.

Table 8. Effect of spraying with organic fertilizers and methods of adding sulfur and the interaction between them on potassium percentage in garlic leaves (%).

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
1.88 D	2.00 ^{e}	1.94 ^{e}	1.71 ^{e}	without spraying (control)
3.05 BC	3.29 ^{cd}	3.01 ^{cd}	2.84 ^{cd}	sheep manure extract
3.26 B	3.48 ^{bc}	3.37 ^{bc}	2.94 ^{cd}	polyamine
3.74 A	4.13 ^{a}	3.97 ^{ab}	3.12 ^{cd}	Humic
2.80 C	2.93 ^{cd}	2.82 ^{cd}	2.65 ^{d}	Compost tea
	3.16 A	3.02 A	2.65 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

The percentage of protein in cloves (%).

The results presented in Table No. 9 showed that the effect of sulfur was significant in increasing the proportion of protein in the cloves, where agricultural sulfur gave the ground addition and liquid sulfur the highest percentage, amounting to 17.24% and 18.23%, respectively, compared to the comparison treatment, whose percentage decreased, which amounted to 13.46%.The results in the same table indicated that the spraying with organic fertilizers was significant in the protein percentage in the cloves. The treatment of spraying with humic acid was superior and gave the highest percentage, which amounted

to 20.72%, followed by the polyamine treatment, which amounted to 19.25%, followed by the treatment of the aqueous extract of sheep waste, which amounted to 16.55%, while the comparison gave the lowest A percentage of 9.23%. As for the interaction between spraying with organic fertilizers and methods of adding sulfur, it was significant. The plants sprayed with both liquid sulfur and humic acid gave the highest percentage of 23.66% compared to the control treatment (without sulfur fertilization and without spraying organic fertilizers), whose percentage decreased and reached 8.77%.

Table 9. Effect of spraying with organic fertilizers and methods of adding sulfur and the interaction between them on the percentage of protein in garlic cloves (%)

Organic Fertilizer average	sulfur treatments			Spraying treatments with organic fertilizers
	liquid sulfur	agricultural sulfur	Without adding sulfur(Control)	
9.36 C	9.60 ^{gh}	9.72 ^{gh}	8.77 ^{h}	without spraying (control)
16.55 B	18.54 ^{bcd}	17.70 ^{bcd}	13.41^{efg}	sheep manure extract
19.25 A	21.27 ^{ab}	20.64 ^{abc}	15.83 ^{def}	polyamine
20.72 A	23.66 ^{a}	21.70 ^{ab}	16.79 ^{cde}	Humic
15.68 B	18.10 ^{bcd}	16.41^{def}	12.52 ^{fgh}	Compost tea
	18.23 A	17.24 A	13.46 B	sulfur average

Note: The averages that share the same letters are not significantly different from each other according to Duncan's polynomial test at the 0.05 probability level.

It is clear from the results presented in Tables 1.2 that there is a significant effect of spraying with liquid sulfur in increasing the vegetative growth traits (plant height and percentage of dry matter).The reason may be attributed to its important role in the synthesis of some important organic compounds in the plant, such as amino acids, vitamins, coenzyme A, and vital proteins such as Ferrodoxins, which are necessary in the process of photosynthesis, nitrate reduction, and nitrogen fixation. It also has an important role in the formation of chlorophyll (14). This is the effect that sulfur plays in its effect on the formation of chlorophyll, which plays an important role in photosynthesis, which was positively reflected on vegetative growth, and consequently the effect of this on the plant height and the percentage of dry matter. The increase in yield (Table 3, 4 and 5) may be attributed to the role of sulfur in revitalizing plants and increasing their growth through activating the photosynthesis process and increasing its efficiency, which was positively reflected in the traits of the yield. As for the reason for the increase in nutrients in the leaves Table 6, 7 and 8, the reason may be attributed to the fact that spraying liquid sulfur on the leaves is easy to be absorbed by the plant and thus provide the sulfur needed by the plant in the process of making chlorophyll, which plays an important role in increasing the efficiency of the photosynthesis process and thus the transmission of part of the nutrients to the roots Which led to an increase in growth, deepening of the roots and their spread, which

led to an increase in the withdrawal of nutrients from the soil and consequently a high percentage inside the leaves (17). the significant effect of ~~The excelled o~~f liquid sulfur in the proportion of protein in cloves may be attributed to the fact that liquid sulfur is included in the composition of some important organic compounds in the plant, such as amino acids such as cysteine and methionine, which combine with other amino acids to manufacture protein, and by increasing potassium, which works on the transfer of these nutrients from the source to the estuary, which led to an improvement Qualitative traits when spraying with liquid sulfur.

The results presented in Table 1.2 showed that there is an effect of spraying with organic fertilizers, as humic outperforms in plant height and dry matter percentage. Amino acids that stimulate the production of auxins responsible for increasing cell division and elongation and thus increases vegetative growth traits, including plant height (10 ; 5)As for the yield and its components (Table 3, 4 and 5), the reason may be due to the role of humic acids in increasing the permeability of cell membranes, which helps speed the entry of nutrients (4).or it may be attributed to the reason for the excelled of the humic acid treatment because of its role in increasing the nutrients necessary for the plant, which was positively reflected in the increase in the traits of the vegetative total, represented by the plant length and the percentage of dry matter, which was positively reflected in the trait of the diameter and weight of the head, which led to an increase in the total yield of heads.Also, tables 6, 7 and 8 indicated a significantly excelled in the percentage of nitrogen, phosphorous and potassium when using humic acid.The reason may be due to the nutrients contained in humic, represented by nitrogen, phosphorous and potassium, which are important elements in the process of carbon metabolism.The excelled of humic in the proportion of protein may be due to what humic contains of nutrients necessary for the plant and organic substances, which led to the improvement of qualitative traits (11).

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