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# Impact of different levels of foamed sulfur and Nitrogen fertilizer (Urea) on soil reaction (pH) and yield of wheat (*Triticum aestivum* L.) cultivar (IBAA 99)

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## Abstract

An experiment was conducted in one of the agricultural lands of Al-Muthanna Governorate for the agricultural season 2018_2019, to find out the effect of adding one of the soil conditioners represented by foamed sulfure by three levels (0, 1000 and 2000) kg S $ha^{-1}$, addition of nitrogen fertilizer (Urea) $CO(NH_2)_2$ at three levels (200, 400 and 600) kg N $ha^{-1}$ to the soil in the degree of soil reaction (pH) and the yield of wheat cultivar (IPAA 99). The treatments within the experimental units were arranged according to the Randomized Complete Block Design (RCBD) with four replicates, so the total experimental units were 36 experimental units, where the level of addition of 2000 kg N $ha^{-1}$ of foamed sulfur and the level of 600 kg N $ha^{-1}$ of nitrogen fertilizer (Urea) were significantly higher, to give them the lowest averages for the soil reaction (pH) of 7.13 and 7.38 at germination and 7.19 and 7.29 at the flowering stage for each of the sulfur and nitrogen fertilizers, respectively, compared to the comparison treatment. Both levels were significantly superior in giving them the highest averages for some growth characteristics, and the yield amounted to(343 and 304 spikes $m^{-2}$, 65 and 62 grains of $spike^{-2}$, 43.58 and 42.20 gm, and 4.88 and 478 tons $ha^{-1}$ and 25.60 and 24.32%, for the characteristics spikes numbers, the grains spike number, 1000 grain weights, grains yield and the protein content percentage in grains, respectively, for both levels.

**Keywords:** foamed sulfur, Nitrogen fertilizer (Urea), soil reaction (pH), yield, wheat (*Triticum aestivum* L.), IBAA 99cultivar.

## Introduction:

Foamy sulfur is considered one of the acidic reformers, as its reactivity is equal to 0.95 at a ratio of 1:1 (Sulfur : water), when added to calcareous soils, it improves its chemical properties. Iraqi soils were calcium carbonate high content salts, $CaCO_3$, it has a high reactivity and tends to be alkaline, reduces the nutreints avialability at soils solution, the trend towards

improving these properties by adding ground sulfur to the soil, increase the availability of nutrients in the soil, because of its importance in increasing the physiological processes in the plant, thus increasing the yield and the fact that the plant cannot complete its life cycle without it. Sulfur is an important element in the plant, it enters the formation of protein through its formation of many amino acids, such as Cysteine and Methionine, exist freely and serve as the basis for building protein in plants, sulfur was a component of many non-essential compounds in plants, contribute to making defense mechanisms against plant pests and diseases or in their role, to give the special taste and distinctive flavor to types of plant foods (Shaker, 1996). The wheat crop is occupies the first place in the list of consumer food commodities, wheat gluten is considered one of the most important grain proteins because it contains high levels of starch and sugars, especially sucrose, makes it a major source of carbohydrates and of great importance in human food (Al-Younes, 1993).

Nitrogen fertilizers are among the industrial chemical fertilizers that are very popular and the market for them is clearly increasing, $CO(NH_2)_2$ Urea fertilizer is considered one of the dry nitrogen fertilizers and the one that contains the most nitrogen element, due to the rapid replacement of ammonium nitrate when placed on the soil surface, Urea fertilizer is also considered a chemical fertilizer with an acidic effect, contributes of the elements in it. Nitrogen is present in the soil in the form of nitrate and ammonium, which are the two forms that plants absorb mainly. Nitrogen is a fast-moving element between the atmosphere, soil, plants, animals and soil organisms, the nitrogen content of the plant ranges from 2-5% of the dry matter, it has an important role in plant life as it increases vegetative growth, as well as "strengthening the root group, which was very necessary for its fixation in the soil on the one hand, at the later stages, it is necessary to "improve the quality of agricultural crops" (Abu Dahi and Al-Younes, 1988).

This study aims to demonstrate the effects of adding of foamed sulfur and Urea on the degree of soil reaction (pH) and yield of wheat (*Triticum aestivum* L.) cultivar (IPAA 99).

## Materials and Methods

The experiment was carried out during the winter season 2018/2019 in one of the agricultural lands located in the Basateen Al-Sharqi area in Al-Muthanna Governorate, to study the effect of adding different levels of foamed sulfur and nitrogen fertilizer (Urea), addition of and yield of wheat cultivar (IPAA 99), sulfur was added ground in three levels (0, 1000, and 2000) kg S $ha^{-1}$ two months before the sowing date, and it was symbolized by the symbols (S0, S1, and S2). Nitrogen fertilizer (Urea) with three levels of application (200, 400, and 600) kg N $ha^{-1}$ was added to the plant as a feeding at planting and at the flowering stage, and it was designated by the symbols (N1, N2, and N3) sequentially in a pot experiment with four replicates.

A composite sample representing the used soil was taken before planting, mixed well, homogenized, air dried, ground, and passed through a sieve with a diameter of 2.0 mm, for the purpose of estimating some chemical and physical properties (Table 1). Prepared 36 plastic pots and put 5 kg of soil from the above field in them. Fertilizer recommendation was added to the anvils by one batch of potassium fertilizer (potassium chloride KCl) and triple superphosphate fertilizer before planting without adding Urea fertilizer. An average of ten seeds of wheat of the cultivar (IPAA 99) were planted in each pot, according to the treatments on 20/11/2019. The process of servicing the crop took place from preparing the soil for planting until harvesting, it included irrigation of each experimental unit, starting from the sowing date until the pre-maturity date, as needed. The process of controlling aphids was carried out using Super Genta pesticide, the experiment was carried out using a completely randomized design (R.C.B.D), the experiment was followed up from irrigation and weeding as needed to the harvest stage, after making sure that the crop is fully ripe, some whole plants were taken to study their yield characteristics.

**Table (1)** Some physical and chemical properties of the study soil before planting.

| ITEM | | Value | Unit |
|---|---|---|---|
| pH | | 7.50 | - |
| E.C. | | 1.60 | ds. $m^{-1}$ |
| C.E.C | | 6.50 | cmol charge $kg^{-1}$ soil |
| Organic Mater | | 2.90 | gm $kg^{-1}$ soil |
| Carbonates | | 0.0 | cmol $kg^{-1}$ soil |
| Bicarbonates | | 2.15 | cmol $kg^{-1}$ soil |
| Available Nitrogen | | 23.00 | mg $kg^{-1}$ soil |
| Available Phosphorus | | 16.50 | mg $kg^{-1}$ soil |
| Available Potassium | | 95.00 | mg $kg^{-1}$ soil |
| Na | | 230.60 | ppm |
| Ca | | 632.40 | ppm |
| K | | 75.60 | ppm |
| Soil properties | Clay | 67.50 | gm $kg^{-1}$ soil |
| | Silt | 136.30 | gm $kg^{-1}$ soil |
| | Sand | 796.20 | gm $kg^{-1}$ soil |
| Soil Texture | | Sandy Loam | |

## Results and Discussions

Table (2) indicates that the addition of foamy sulfur to the soil increased, reduce the degree of soil reaction in the germination stage. The level of foamy sulfur addition of 2000 kg S $ha^{-1}$ was superior in giving it the lowest average soil reaction level of 7.13, compared to the no-add treatment, which gave the highest mean for this trait amounted to 8.03, and the level of 2000 kg S $ha^{-1}$ was significantly superior to the level of 1000 kg S $ha^{-1}$, was significantly superior to the level of 0 kg S $ha^{-1}$, this effect is caused by the activity of the microorganisms of *Thiobacillus thioparus*. Two months after adding

foamy sulfur to the soil, performs the process of oxidizing sulfur and liberating hydrogen ions, led to a decrease in the degree of soil interaction and an increase in the readiness of the elements in the soil. These results agree with the findings of Abu Dahi (1999), Al-Adhami *et al*. (2001), Latif (2006), Aliwi and Al-Shamaa (2008), and Al-Bayati *et al*. (2009), those who mentioned the presence of a significant effect of increasing the amount of sulfur in reducing the degree of soil reaction, it also exceeded the level of 600 kg N ha$^{-1}$ of nitrogen fertilizer, at the levels of 200 and 400 kg N ha$^{-1}$, giving it the lowest average soil reaction score of 7.38.

Table (2) also shows interaction between concents of foamed sulfur and nitrogen fertilizer, the sulfur treatment at the level of 2000 kg S ha$^{-1}$ was significantly superior in giving it the lowest values for the mean soil reaction of 7.01, 7.16 and 7.23, compared with the comparison treatment, which gave the highest averages for this trait, which amounted to 8.15, 8.09 and 7.85.

**Table (2)** The effect of foam sulfur and nitrogen fertilizer levels on the degree of soil reaction (pH) upon germination.

| **Nitrogen fertilizer (kg N ha$^{-1}$)** | | **foam sulfur (kg S ha$^{-1}$)** | | | **N Mean** |
|---|---|---|---|---|---|
| | | **S0** | **S1** | **S2** | |
| | | **0** | **1000** | **2000** | |
| **N1** | **200** | 8.15 | 7.22 | 7.01 | 7.46 |
| **N2** | **400** | 8.09 | 7.18 | 7.16 | 7.48 |
| **N3** | **600** | 7.85 | 7.06 | 7.23 | 7.38 |
| **S Mean** | | 8.03 | 7.15 | 7.13 | |
| L.S.D$_{0.05}$ | | N | S | N*S | |
| | | 0.05 | 0.06 | 0.09 | |

Table (3) shows adding sulfur and nitrogen fertilizer to the soil in reducing the degree of soil reaction. The level of addition of 2000 kg S ha$^{-1}$ gave it the lowest average soil reaction level of 7.19, compared to the comparison treatment, which gave the highest mean for this trait, it was 8.04. The level of adding nitrogen fertilizer (Urea) at 600 kg N ha$^{-1}$ was the low (7.29), compared with the two levels of 200 and 400 kg N ha$^{-1}$, which gave the highest mean for this characteristic, which amounted to 7.87 and 7.73, respectively. The reason for this is due to reducing the degree of soil interaction, contributes to increasing the availability of nutrients in it,

Table (3) also shows the significant effect of the interaction between sulfur levels and nitrogen fertilizers. The sulfur treatment at the level of 2000 kg S ha$^{-1}$ was significantly superior in giving it the lowest values for the average soil reaction of 7.27, 7.17 and 7.13, compared with the comparison treatment, which gave the highest averages for this trait, which amounted to 8.58, 8.36, and 7.19.

**Table (3)** The effect of foam sulfur and nitrogen fertilizer levels on the degree of soil reaction (pH) when flowering.

| Nitrogen fertilizer (kg N ha$^{-1}$) | | foam sulfur (kg S ha$^{-1}$) | | | N Mean |
|---|---|---|---|---|---|
| | | S0 | S1 | S2 | |
| | | 0 | 1000 | 2000 | |
| N1 | 200 | 8.58 | 7.75 | 7.27 | 7.87 |
| N2 | 400 | 8.36 | 7.67 | 7.17 | 7.73 |
| N3 | 600 | 7.19 | 7.54 | 7.13 | 7.29 |
| S Mean | | 8.04 | 7.65 | 7.19 | |
| L.S.D$_{0.05}$ | | N | S | N*S | |
| | | 0.08 | 0.12 | N.S | |

Table (4) shows that there is a significant effect of adding foamed sulfur on the characteristic of the number of spikes. The level of addition of 2000 kg S ha$^{-1}$ gave the highest means, which reached 343 spikes m$^{-2}$, compared to the non-addition treatment, which gave the least average of 238 spikes m$^{-2}$, This level was also significantly superior to the level of addition of 1000 kg S ha$^{-1}$, which, in turn, was significantly superior, with an average of 271 spikes m$^{-2}$, over the comparison treatment without addition, due to the increased availability of nutrients, especially the microelements of the low reactivity of the soil, the plant branching, increasing element readiness also led to more production of flower facilities, agrees with the findings of Al-Saadi (2006).

The results also showed that increasing the levels of nitrogen fertilizer application led to an increase in the spkes number perm$^{2}$. Treatment of adding nitrogen fertilizer (600 kg N ha$^{-1}$) was high ( 304 spikes m$^{-2}$), it was superior to the two addition treatments of 200 and 400 kg N ha$^{-1}$, whose values were 265 and 284 spike m$^{-2}$, respectively. This was attributed to the fact that nitrogen fertilizer has increasing process outputs, in addition to the effect of nitrogen, which works to increase the division and expansion of cells, vegetative buds number increasing of and the spike-bearing branches number (Al-Alawi, 2011; Abu Dahi *et al*., 2005).

**Table (4)** Effect of levels of foamed sulfur and nitrogen fertilizer on the number of spikes (spike m$^{-2}$).

| Nitrogen fertilizer (kg N ha$^{-1}$) | | foam sulfur (kg S ha$^{-1}$) | | | N Mean |
|---|---|---|---|---|---|
| | | S0 | S1 | S2 | |
| | | 0 | 1000 | 2000 | |
| N1 | 200 | 228 | 258 | 310 | 265 |
| N2 | 400 | 235 | 272 | 344 | 284 |
| N3 | 600 | 251 | 284 | 376 | 304 |
| S Mean | | 238 | 271 | 343 | |
| L.S.D$_{0.05}$ | | N | S | N*S | |
| | | 24.26 | 24.61 | N.S | |

Table (5) indicates that 2000 kg S $ha^{-1}$ was significantly superior to the no-additive treatment and gave the highest mean for this trait, which reached 65 grains of $spike^{-1}$, compared to the control treatment that gave the least average of 52 grains of $spike^{-1}$, it also exceeded the addition treatment at 1000 kg S $ha^{-1}$, which in turn outperformed the comparison treatment with an average of 57 grains of $spike^{-1}$, it also exceeded the level of addition of 600 kg N $ha^{-1}$ in giving it the highest average (62 grains of $spike^{-1}$), compared to 200-400 kgN $ha^{-1}$, was low average of 54 57 grians of $spike^{-1}$, respectively. It may cause a decrease in soil interaction degree and an increase in the elements readines, it also increases the level of nitrogen addition to the soil, may lead to an increase in the readiness of this element, which works to increase the process of fertilization with wheat, f For its role in improving the fertility status of most of the florets in the spike, which makes it more ready to contract and form seeds, it also works to increase the vegetative total (Al-Alawi, 2011).

**Table (5)** Effct of faomed sulfurs and nitrogen fertilizr levels on grains number per spike (grains of $spike^{-1}$).

| **Nitrogen fertilizer (kg N $ha^{-1}$)** | | **foam sulfur (kg S $ha^{-1}$)** | | | **N Mean** |
|---|---|---|---|---|---|
| | | **S0** | **S1** | **S2** | |
| | | **0** | **1000** | **2000** | |
| **N1** | **200** | 47 | 54 | 62 | 54 |
| **N2** | **400** | 52 | 56 | 64 | 57 |
| **N3** | **600** | 57 | 61 | 68 | 62 |
| **S Mean** | | 52 | 57 | 65 | |
| $L.S.D_{0.05}$ | | N | S | N*S | |
| | | 1.10 | 1.40 | N.S | |

Table (6) shows that there was a significant increase in the weight of 1000 grains with an increase in the level of sulfur addition to the soil. The treatment of 2000 kg S $ha^{-1}$ excelled by giving it the highest averages for this characteristic, amounting to 43.58 gm, to control, was low average (37.56 gm), it also surpassed the 1000 kg S $ha^{-1}$ level, was significantly superior to the comparison treatment. increase readiness and nutrients absorpt, especially smaller items, the represented substances and then increased plant growth, by equipping downstream, led to an increase in the weight of 1000 grain, this was agreed with Taj Al-Din (1979) and Abu Dahi (1999) reached.

Increasing the percentage of nitrogen fertilizer (Urea) to 600 kg N $ha^{-1}$ achieved a significant increase in the weight of 1000 grains, it surpassed this level by giving it the high (42.20 gm), compared with 200-400 kg N $ha^{-1}$, was low (38.87 and 40.22 gm). The reason for this is due to the role of nitrogen in prolonging the effective period of grain filling by reducing leaf aging (Al-Badrani and Al-Roumi, 2013).

**Table (6)** Effect of levels of foamed sulfur and nitrogen fertilizer on the weight of 1000 grains (gm).

| Nitrogen fertilizer (kg N $ha^{-1}$) | | foam sulfur (kg S $ha^{-1}$) | | | N Mean |
|---|---|---|---|---|---|
| | | S0 | S1 | S2 | |
| | | 0 | 1000 | 2000 | |
| N1 | 200 | 36.22 | 38.04 | 42.36 | 38.87 |
| N2 | 400 | 37.31 | 40.24 | 43.10 | 40.22 |
| N3 | 600 | 39.16 | 42.15 | 45.29 | 42.20 |
| S Mean | | 37.56 | 40.14 | 43.58 | |
| $L.S.D_{0.05}$ | | N | S | N*S | |
| | | 1.23 | 1.36 | N.S | |

Table (7) shows the superiority of the sulfur addition treatment 2000 kg S $ha^{-1}$ was the high (4.88 tons $ha^{-1}$), compared to the comparison treatment, the level of 2000 kg S $ha^{-1}$ was also superior to 1000 kgS $ha^{-1}$. The grain yield increased significantly as a result of adding levels of 2000 and 4000 kg S$ha^{-1}$ compared to the treatment without adding sulfur, the results also agree with what Bektash and Kadhem (2002) concluded that the addition of sulfurs to a significan increas in yield.

Table (7) showed that Urea 600 kg N $ha^{-1}$ was significantly superior in giving it the highest average for this characteristic, which amounted to 4.78 tons $ha^{-1}$, compared to 200-400 kgN $ha^{-1}$, due to the effect of N fertilization on increasing spike numbers $perm^2$, spike length, grain numbers per spike, and 1000 grains weight, led to an increase in grain yield.

**Table (7)** Effect of foamed sulfur and nitrogen fertilizer levels on grain yield (ton $ha^{-1}$).

| Nitrogen fertilizer (kg N $ha^{-1}$) | | foam sulfur (kg S $ha^{-1}$) | | | N Mean |
|---|---|---|---|---|---|
| | | S0 | S1 | S2 | |
| | | 0 | 1000 | 2000 | |
| N1 | 200 | 3.47 | 4.21 | 4.64 | 4.11 |
| N2 | 400 | 4.33 | 4.58 | 4.80 | 4.57 |
| N3 | 600 | 4.42 | 4.73 | 5.19 | 4.78 |
| S Mean | | 4.07 | 4.51 | 4.88 | |
| $L.S.D_{0.05}$ | | N | S | N*S | |
| | | 0.12 | 0.18 | N.S | |

Table (8) show the superiority of adding foamy sulfur at the level of 2000 kg S $ha^{-1}$ was high average protein percentage of 25.60%, over the comparison treatment, which gave the lowest average of 20.58%. The level of 2000 kg S $ha^{-1}$ was also superior to the level of addition of 1000 kg S $ha^{-1}$. Sulfurs-containing amino acids in the plant, exist in the form of free acids

and also act as building blocks in protein, these results agree with the findings of Al-Saadi (2006), Al-Abadi (2006), and Al-Fahdawi (2008), that increasing the addition of sulfur to the soil has a significant effect on increasing the proportion of protein in grains. The level of adding Urea 600 kgN $ha^{-1}$ was high mean (24.32%), compared to 200-400 kgN $ha^{-1}$, was the low (22.26% and 23.12%, respectively). The reason for this may be due to the fact that nitrogen is one of the main components of amino acids, which was the cornerstone of protein formation, nitrogen is included in the composition of its amine group, contribute to increasing the proportion of protein in grains (Heldt, 2005).

**Table (8)** Effects of faomed sulfurs levels and nitrogen fertilizers on the grains protein percentages (%).

| Nitrogen fertilizer (kg N $ha^{-1}$) | | foam sulfur (kg S $ha^{-1}$) | | | N Mean |
|---|---|---|---|---|---|
| | | S0 | S1 | S2 | |
| | | 0 | 1000 | 2000 | |
| N1 | 200 | 19.73 | 22.73 | 24.33 | 22.26 |
| N2 | 400 | 20.48 | 23.68 | 25.21 | 23.12 |
| N3 | 600 | 21.52 | 24.19 | 27.26 | 24.32 |
| S Mean | | 20.58 | 23.53 | 25.60 | |
| $L.S.D_{0.05}$ | | N | S | N*S | |
| | | 0.15 | 0.18 | N.S | |

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