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# RESPONSE OF ARTICHOKE PLANTS TO AGRICULTURE SULPHUR AND CHICKEN MANURE APPLICATION

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## ABSTRACT

Two field experiments were carried out in newly reclaimed land at El-Nobaria, Northern Egypt during the two successive seasons of 2004/2005 and 2005/2006 to study the response of artichoke plants (cv. Herious) to 3 application rates of both agriculture sulphur (0, 150 and 300 kg/feddan [4200 $m^2$]) and nitrogen (80, 100 and 120 kg/feddan). Whereas, as chicken manure contains 3.4% N was used as nitrogen sourse. Vegetative growth characters, head yield and its quality as well as plant chemical composition were recorded. The important obtained results were as follows:

- Addition of agriculture sulphur up to 300 kg/fed. resulted in the best growth characters (plant height, leaves number/plant, leaf area, fresh and dry weight), total chlorophyll content as well as head yield and its quality. But, the increase of nutritional elements (N, P, K, Ca, and Fe) in leaves and edible part (receptacle) of artichoke plants was not great enough to be significant.
- With increasing the application rate of chicken manure within the range of 80 up to 120 kg N/fed., all studied plant growth characters (plant height, leaves number/plant, leaf area, leaf fresh and dry weight), total chlorophyll content and head yield and its quality gradually and constant increased. While, no significant variation in nutritional elements (N, P, K, Ca, and Fe) values in leaves and edible part (receptacle) was recorded.
- There is no great effect of the interaction treatments between both sulphur and chicken manure rates on plant growth, productivity and head quality of artichoke plants, but generally the highest values of most measurements were associated with addition of the highest rate of both agriculture sulphur (300 kg/fed.) and chicken manure (120 kg N/fed.).
- It could be concluded that, from the economical view, the addition of both 150 kg/fed. of agriculture sulphur and 100 kg N/fed., as chicken manure is the most useful and beneficial for growing artichoke plants under the condition of the experiment.

**Keywords:** Globe artichoke, agriculture sulphur, chicken manure, N

## INTRODUCTION

Globe artichoke (*Cynara cardunculus* L. var. scolymus (L.) Fiori) is a large immature flower rich in nutritional and medicinal substances. It is considered one of the most important vegetable crops in the countries bordering the Mediterranean basin including Egypt. The world production of globe artichoke increased from 1.141 to 1.290 million tons from 1995 to 2000 (Behr, 2001).

Globe artichoke has important nutritional values related to its high content of cynarin, fibres and minerals. Extracts containing cynarin have effect on hepatobiliary diseases, hyperlipidaemia, dropsy, rheumatism and

cholesterol metabolism. Artichoke is a species of great pharmacological interest because of its coleretic and hepato-regenerative action induced by the aqueous extracts of leaves (Wagenbreth, 1996; Gebhardt, 1997; Gebhardt and Fausel, 1997; Gebhardt, 1998).

Among the major nutrients, nitrogen is required in the largest amount by plants. It plays an essential role for plant productivity (Marschner, 1995). Artichoke productivity is strongly affected by the amount of nitrogen. Salamah, 1997; Saleh, 2003; Saleh, *et al.,* 2003 recommended to apply 100:120 kg N/fed. However, increasing the used of chemical fertilizers led to an environmental pollution. Therefore, it is advisable to pay a special attention to use safe agriculture system for artichoke production according to its nutritional and medicinal values. Now consumers are extremely health conscious. As a result they want vegetables rich in vitamins and minerals. Vegetables containing toxic compounds such as nitrate or heavy metals will not be highly marketable to consumers. Thus, it is of the most important to use natural resources for plant nutrition. Organic manure such as chicken manure contains higher levels of relatively available nutrient elements, which are essentially required for plant growth and its productivity. Moreover, it plays an important role for improving soil physical properties. The supplied vegetable crops with organic fertilizer were proved to be very essential for the production of higher yield and for improving its quality (Abdallah, *et al.,* 2001 and Fatma, 2001; Shafeek, 2003; Fawzy, *et al.,* 2006). Sulphur deficiency is becoming a serious problem for Egyptian soil. Sulphur fertilization is a feasible technique for lowering the plant uptake of undesired or toxic elements in the polluted soils (Schnug, 1990). Also, sulphur is the fourth most important nutrient is required in relatively large amount for plant growth (Marschner, 1995). Addition sulphur with chicken manure for vegetables caused better results, because the role of sulphur for lowering the pH value in soil extract and their turn on increasing the solubility and availability of many minerals (Schnug, 1990; Ragab, 2000; Abdel-Moez, *et al.,* 2001; Shafeek, *et al.,* 2003).

The present investigation was conducted to study the effect of agriculture sulphur and chicken manure on artichoke productivity and product quality.

## MATERIALS AND METHODS

Two field trials were conducted out in newly reclaimed soil at El-Nobaria, El-Behira Governorate, Northern of Egypt during the two successive seasons of 2004/2005 and 2005/2006. The soil texture is sandy with 95.3% sand, 0.4% silt and 4.3% clay. The pH was 7.9 and EC was 2.0 dS/m.

Two-factorial experiment was carried out in a split plot design with three replicates. Three agricultural sulphur treatments, i.e., 0, 150 and 300 kg/feddan (Factor A) were assigned to the main-plots, while three N levels, i.e., 80, 100 and 120 kg N/feddan as chicken manure contains 3.4% N (Factor B) were randomized and occupied the sub-plots. The chemical analysis of the used chicken manure is presented in Table (1). The plot area

was 22.5 $m^2$ containing 15 artichoke plants. Before planting, all sulphur and chicken manure treatments were soil-incorporated. Drip irrigation system was used and other agricultural practices such as phosphorus and potassium fertilization, weed control and pest management were followed according to the recommendation of the Ministry of Agriculture, Egypt.

The French cultivar, cv. Herious, (vegetatively propagated), was grown on September 1st and 3rd for first and second seasons, respectively, with 100 cm apart between each two plants on the ridge and 150 cm between the ridges. The first harvest of buds started in January and continued until the end of May in both growing seasons.

**Table (1): The chemical analysis of the used chicken manure during both growing seasons (Average of the two experimental seasons).**

| Properties | Values |
|---|---|
| pH | 6.5 |
| EC (dS/m) | 8.2 |
| Organic matter (%) | 50.5 |
| Total nitrogen (%) | 3.4 |
| Total phosphorous (%) | 1.14 |
| Total potassium (%) | 1.8 |
| Iran (mg/kg) | 3860 |
| Manganese (mg/kg) | 241 |
| Copper (mg/kg) | 54 |
| Zinc (mg/kg) | 120 |

Three vegetative plant samples were taken at 90, 120 and 150 days after planting and the following measurements were recorded: Plant height (cm), Number of leaves/plant, Leaf area ($cm^2$), Leaf fresh weight (g), Leaf dry weight (g), Leaf chlorophyll content (SPAD). As representative sample, the 4th-youngest leaf was taken to determine leaf area, fresh and dry weight as well as chlorophyll content. Early yield was determined as weight and number of heads/plant from starting of harvest until the end of February, but total yield of heads was recorded as weight and number of heads per plant from the beginning of harvest until the end of growing season. The weight, length and diameter of each head as well as the weight of edible part (receptacle) were evaluated in February (main heads) and in April (secondary heads).

For chemical analyses, plant materials, i.e. leaves as well as edible head parts were dried for 3 days in an oven at 70°C. Afterwards, the samples were ground with a Culatti MFC grinder equipped with a 1-mm sieve. Total nitrogen was determined according to a modified method of Kjeldahl (Horneck and Miller, 1998). The rate of crude protein in the edible part of the heads was calculated from the total N-content corrected with an appropriate conversion factor according to the correlation (AOAC, 1975): % Crude protein = % N x 6.25. The crude fiber fraction based on the determination of the mass lost after dry ashing of the sample before both acid and alkaline

treatment. The mass lost corresponds to the content of the crude fiber in the sample (Anonymous, 1992). Potassium, Ca and Fe were measured by the flame AAS (VARIAN Spectra AA 100) according to Chapman and Pratt (1978), but P content was determined photometrically as yellow colored molybdatophosphate at a wavelength of 430 nm using a HITACHI Spectrophotometer, model U-3200 according to AOAC (1975).

**Statistical analysis**

All data values were subjected to the analysis of variance according to Gomez and Gomez, 1984.

## RESULTS AND DISCUSSION

**A. Plant growth and leaf chlorophyll content:**

**1. Effect of sulphur addition:**

Artichoke plant growth characters, i.e. plant height, leaves number, fresh, dry weight of leaf as well as leaf area and leaf pigment content (total chlorophyll), all of them significantly influenced by different addition rates of agriculture sulpher (Tables 2 and 3). These were true during the different plant growth ages, i.e. 90, 120 and 150 days after planting in both experimental seasons. As a general, addition of sulphur up to 300 kg/fed. gradually and constant increased the all studied plant growth properties. However, the obtained data reveals that, the addition of 150 kg of sulphur/fed. greatly and clearly enhanced the plant growth criteria's comparing with the no-sulphur addition. Moreover, addition 300 kg sulphur/fed. increased no significantly the plant growth values comparing with addition of 150 kg. These findings are true for most plant growth characters. These were completely similar with different plant ages in the two experimental seasons.

It could be concluded that, the economical and useful rate of sulphur addition for artichoke plants is within 150 and 300 kg/fed., where, no great variation is obtained within addition of 150 and 300 kg sulphur/fed.

The superiority of artichoke plants which received the agricultural sulphur may be attributed to the mode of action of sulphur in soil media. Many investigators reported that, addition sulphur into soil caused a decrease in pH value of soil resulted in an increase in the solubility and availability of many mineral elements, it reflected on the plant growth (Hassaneen, 1992; Abdel-Moez, *et al.*, 1997; El-Maghraby, *et al.*, 1997; Ragab, 2000; Abdel-Moez, *et al.*, 2001; Shafeek, *et al.*, 2003).

**2. Effect of chicken manure:**

Chicken manure as an organic nitrogen source for artichoke plants fertilization at different plant stages in both two seasons of 2004/2005 and 2005/2006 influenced the growth criteria's of artichoke as shown in Tables (2 and 3). With increasing the rate of chicken manure addition within the range of 80 up to 120 kg N/fed., plant height, leaves number/plant, leaf area, fresh and dry weight as well as leaf pigments (total chlorophyll), all of them recorded an increase. This means that, the vigor plant growth was associated with addition the highest chicken manure rate, but the statistical analysis of the obtained data reveals that, in most plant growth criteria's had

no significant differences between addition of 100 and/or 120 kg N per feddan as chicken manure. These findings are held good at different plant growth ages in both two experimental seasons. However, the values of plant growth characters recorded significant variations within addition of 80 and 120 kg N/fed. These were true for all studied parameters except that of dry leaf at various stages of plant growth in both growing seasons.

It could be summarized that, from the economical view, the addition of 100 kg N/fed., as chicken manure is the most useful and beneficial for growing artichoke plants at least under the condition of this study.

With respect of using chicken manure as a source of organic nitrogen for vegetable plants, the reviews had an agreement as that, it great influenced plant growth characters (Mokaden, 2000; Abdel-Moety, *et al.*, 2001; Fatma, 2001; Shafeek, *et al.*, 2003; Fawzy, *et al.*, 2006).

**3. Effect of the interaction:**

Tables (2 and 3) show the response of plant growth characters of artichoke plants at different ages in both growing seasons to addition of different rates of agricultural sulphur and different rates of chicken manure as interaction treatments. Whereas, the statistical analysis of the obtained data showed that, the response of all plant parameters was not great enough to be significant at 5% level. These were true for different plant stages in both growing seasons. This indicates that, each of the two interaction factors acts independently.

**B. Total and early head yield:**

**1. Effect of sulphur addition:**

The obtained data of Table (4) clearly shows that, with increasing the application rate of agriculture sulphur, the total and early yield of artichoke heads increased significantly, whereas, these increments were gradually and consistently. It means that, the heaviest total head yield as g/plant (2629.8 - 2527.8 g) as well as early head yield (645.6 - 608.9 g) were associated with addition of the highest level of sulphur (300 kg/fed.) during 1$^{st}$ and 2$^{nd}$ seasons, respectively. On the contrary, the lowest values were associated with no adding sulphur (zero sulphur). It could be concluded that, the total yield and early yield of artichoke heads, respectively, recorded increases amounted by 35.2 and 27.6% in 1$^{st}$ season and by 29.7 and 43.1% in 2$^{nd}$ season when that plants received 300 kg of agricultural sulphur per fed. if compared by that plants which no sulphur addition.

The mean head weight of artichoke yield responded by the addition of agriculture sulphur completely as like before mention of total and early yield. Also, the average number of total heads/plant and/or average number of early heads/plant followed the same pattern of change as described above. These all findings were true in both experimental seasons.

It could be concluded that, agriculture sulphur plays a great role to enhance the head weight and number of both total and early yield of artichoke heads. These obtained results are in good accordance with that which recorded by many investigators (Fatma, 2001; El-Desuki and Sawan, 2001; Shafeek, *et al.*, 2003). Whereas, sulphur application to the soil has been recently introduced as along term fertilizer.

Table (2): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on vegetative growth of artichoke plants in 1st season 2004/2005.

| Treatments(A) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | | LSD at 5% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characters (B) | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | A | B | AxB |
| *after 90 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 38.3 | 40.0 | 41.0 | *39.8* | 40.3 | 41.3 | 43.7 | *41.8* | 41.0 | 41.7 | 43.7 | *42.1* | 39.9 | 41.0 | 42.8 | *0.8* | *1.4* | *ns* |
| Leaves no./plant | 24.0 | 25.7 | 27.0 | *25.6* | 25.0 | 27.0 | 28.3 | *26.8* | 26.3 | 29.0 | 30.3 | *28.5* | 25.1 | 27.2 | 28.5 | *1.8* | *1.4* | *ns* |
| Leaf fresh W., g | 72.3 | 74.0 | 75.3 | *73.9* | 74.3 | 75.3 | 80.3 | *76.6* | 76.7 | 79.0 | 80.0 | *78.6* | 74.4 | 76.1 | 78.5 | *2.1* | *1.9* | *ns* |
| Leaf dry weight, g | 11.0 | 11.9 | 12.3 | *11.7* | 12.1 | 12.5 | 13.1 | *12.6* | 12.8 | 13.1 | 13.3 | *13.1* | 12.0 | 12.5 | 12.9 | *ns* | *ns* | *ns* |
| Leaf area, $cm^2$ | 426.7 | 435.7 | 445.7 | *436.0* | 440.7 | 449.7 | 463.0 | *451.1* | 456.7 | 462.3 | 466.3 | *461.8* | 441.4 | 449.2 | 458.3 | *6.3* | *12.2* | *ns* |
| Chlorophyll, SPAD | 44.9 | 46.3 | 47.8 | *46.3* | 46.3 | 47.0 | 48.9 | *47.4* | 48.3 | 49.8 | 51.4 | *49.8* | 46.5 | 47.7 | 49.4 | *1.2* | *1.4* | *ns* |
| *after 120 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 44.3 | 46.7 | 47.3 | *46.1* | 48.0 | 49.0 | 50.3 | *49.1* | 49.3 | 50.7 | 51.3 | *50.4* | 47.2 | 48.8 | 49.6 | *2.2* | *1.3* | *ns* |
| Leaves no./plant | 39.7 | 41.0 | 44.3 | *41.7* | 43.3 | 46.0 | 47.7 | *45.7* | 45.7 | 48.3 | 49.3 | *47.8* | 42.9 | 45.1 | 47.1 | *2.2* | *1.5* | *ns* |
| Leaf fresh W., g | 91.7 | 94.0 | 95.7 | *93.8* | 94.3 | 96.3 | 97.7 | *96.1* | 96.7 | 98.3 | 100.7 | *98.6* | 94.2 | 96.2 | 98.0 | *1.0* | *2.0* | *ns* |
| Leaf dry weight, g | 12.7 | 13.1 | 13.4 | *13.1* | 13.3 | 14.1 | 14.6 | *14.0* | 14.2 | 14.7 | 15.2 | *14.7* | 13.4 | 14.0 | 14.4 | *1.2* | *ns* | *ns* |
| Leaf area, $cm^2$ | 452.0 | 465.7 | 470.3 | *462.7* | 465.0 | 467.7 | 471.3 | *468.0* | 467.0 | 482.7 | 481.7 | *477.1* | 461.3 | 472.0 | 474.4 | *8.5* | *ns* | *ns* |
| Chlorophyll, SPAD | 45.1 | 44.9 | 47.6 | *45.9* | 46.4 | 46.5 | 47.8 | *46.9* | 48.7 | 50.0 | 49.8 | *49.5* | 46.7 | 47.1 | 48.4 | *2.1* | *1.4* | *ns* |
| *after 150 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 60.3 | 62.3 | 64.3 | *62.3* | 62.3 | 65.0 | 67.3 | *64.9* | 66.0 | 68.3 | 69.7 | *68.0* | 62.9 | 65.2 | 67.1 | *1.7* | *2.4* | *ns* |
| Leaves no./plant | 51.3 | 55.0 | 55.7 | *54.0* | 53.3 | 55.7 | 57.7 | *55.6* | 57.7 | 59.0 | 60.0 | *58.9* | 54.1 | 56.6 | 57.8 | *3.4* | *2.1* | *ns* |
| Leaf fresh W., g | 95.3 | 97.0 | 100.0 | *97.4* | 97.3 | 101.0 | 104.0 | *100.8* | 102.3 | 104.3 | 105.3 | *104.0* | 98.3 | 100.8 | 103.1 | *2.0* | *1.6* | *ns* |
| Leaf dry weight, g | 13.3 | 14.3 | 15.3 | *14.3* | 14.4 | 14.9 | 15.4 | *14.9* | 15.6 | 15.7 | 15.6 | *15.6* | 14.4 | 15.0 | 15.4 | *0.9* | *ns* | *ns* |
| Leaf area, $cm^2$ | 471.7 | 478.3 | 485.3 | *478.4* | 476.0 | 484.3 | 494.3 | *484.9* | 481.0 | 488.3 | 504.3 | *491.2* | 476.2 | 483.6 | 494.6 | *8.6* | *12.6* | *ns* |
| Chlorophyll, SPAD | 46.6 | 47.0 | 48.3 | *47.3* | 47.6 | 50.3 | 50.7 | *49.5* | 49.9 | 51.9 | 51.1 | *51.0* | 48.0 | 49.7 | 50.0 | *1.6* | *1.0* | *ns* |

**Table (3): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on vegetative growth of artichoke plants in 2nd season 2005/2006.**

| Treatments (A) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | | LSD at 5% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characters (B) | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | A | B | AxB |
| *after 90 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 39.3 | 40.0 | 42.0 | *40.4* | 39.7 | 42.0 | 43.0 | *41.6* | 42.0 | 44.0 | 45.0 | *43.7* | 40.3 | 42.0 | 43.3 | *ns* | *1.4* | *ns* |
| Leaves no./plant | 25.3 | 26.7 | 27.3 | *26.4* | 27.0 | 28.3 | 29.3 | *28.2* | 27.7 | 29.0 | 28.7 | *28.5* | 26.7 | 28.0 | 28.4 | *1.1* | *ns* | *ns* |
| Leaf fresh W., g | 72.7 | 75.3 | 76.0 | *74.7* | 74.3 | 76.3 | 78.0 | *76.2* | 76.7 | 78.7 | 80.3 | *78.6* | 74.6 | 76.8 | 78.1 | *ns* | *1.5* | *ns* |
| Leaf dry weight, g | 10.2 | 10.5 | 10.9 | *10.5* | 11.2 | 11.6 | 11.8 | *11.5* | 11.1 | 11.8 | 12.2 | *11.7* | 10.8 | 11.3 | 11.6 | *ns* | *ns* | *ns* |
| Dry matter, % | 14.0 | 13.9 | 14.3 | *14.1* | 15.1 | 15.2 | 15.1 | *15.1* | 14.5 | 15.0 | 15.2 | *14.9* | 14.5 | 14.7 | 14.9 | *ns* | *ns* | *ns* |
| Leaf area, $cm^2$ | 439.7 | 460.3 | 466.7 | *455.6* | 458.0 | 465.0 | 475.3 | *466.1* | 463.3 | 472.0 | 480.3 | *471.9* | 453.7 | 465.8 | 474.1 | *4.3* | *15.4* | *ns* |
| Chlorophyll, SPAD | 46.2 | 47.9 | 48.6 | *47.6* | 47.4 | 48.6 | 50.8 | *48.9* | 51.2 | 51.9 | 52.4 | *51.8* | 48.3 | 49.5 | 50.6 | *1.6* | *1.5* | *ns* |
| *after 120 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 46.3 | 46.7 | 49.3 | *47.4* | 48.7 | 50.7 | 51.3 | *50.2* | 50.7 | 52.5 | 52.7 | *52.0* | 48.6 | 50.0 | 51.1 | *2.4* | *1.9* | *ns* |
| Leaves no./plant | 42.3 | 44.0 | 45.7 | *44.0* | 44.0 | 46.7 | 47.3 | *46.0* | 46.7 | 49.3 | 50.0 | *48.7* | 44.3 | 46.7 | 47.7 | *1.7* | *2.0* | *ns* |
| Leaf fresh W., g | 95.0 | 97.0 | 100.7 | *97.6* | 100.0 | 101.3 | 103.7 | *101.7* | 100.3 | 104.0 | 107.0 | *103.8* | 98.4 | 100.8 | 103.8 | *2.7* | *1.7* | *ns* |
| Leaf dry weight, g | 12.0 | 12.5 | 12.9 | *12.5* | 12.7 | 13.4 | 13.8 | *13.3* | 12.9 | 14.3 | 14.6 | *13.9* | 12.5 | 13.4 | 13.8 | *1.0* | *ns* | *ns* |
| Dry matter, % | 12.6 | 12.9 | 12.8 | *12.8* | 12.7 | 13.2 | 13.3 | *13.1* | 12.9 | 13.8 | 13.6 | *13.4* | 12.7 | 13.3 | 13.3 | *ns* | *ns* | *ns* |
| Leaf area, $cm^2$ | 469.7 | 481.0 | 495.0 | *481.9* | 486.3 | 492.3 | 500.3 | *493.0* | 487.0 | 500.7 | 505.3 | *497.7* | 481.0 | 491.3 | 500.2 | *ns* | *12.0* | *ns* |
| Chlorophyll, SPAD | 46.8 | 48.2 | 47.9 | *47.6* | 47.3 | 48.3 | 50.2 | *48.6* | 49.8 | 50.6 | 51.7 | *50.7* | 48.0 | 49.0 | 49.9 | *1.4* | *ns* | *ns* |
| *after 150 days from planting* | | | | | | | | | | | | | | | | | | |
| Plant height, cm | 61.0 | 62.3 | 63.7 | *62.3* | 62.3 | 65.3 | 68.0 | *65.2* | 66.3 | 69.7 | 71.0 | *69.0* | 63.2 | 65.8 | 67.6 | *0.8* | *1.0* | *ns* |
| Leaves no./plant | 49.7 | 53.0 | 56.3 | *53.0* | 52.7 | 55.3 | 56.7 | *54.9* | 53.7 | 58.7 | 58.3 | *56.9* | 52.0 | 55.7 | 57.1 | *1.1* | *0.9* | *1.6* |
| Leaf fresh W., g | 94.0 | 95.3 | 97.7 | *95.7* | 95.3 | 99.7 | 101.0 | *98.7* | 99.7 | 102.7 | 103.0 | *101.8* | 96.3 | 99.2 | 100.6 | *2.1* | *1.3* | *ns* |
| Leaf dry weight, g | 13.3 | 13.5 | 14.0 | *13.6* | 13.6 | 14.4 | 14.5 | *14.2* | 14.5 | 14.8 | 14.8 | *14.7* | 13.8 | 14.2 | 14.4 | *0.3* | *0.2* | *0.3* |
| Dry matter, % | 14.1 | 14.2 | 14.3 | *14.2* | 14.3 | 14.4 | 14.4 | *14.4* | 14.5 | 14.4 | 14.4 | *14.4* | 14.3 | 14.3 | 14.4 | *0.1* | *ns* | *ns* |
| Leaf area, $cm^2$ | 464.3 | 475.3 | 476.3 | *472.0* | 473.3 | 481.0 | 478.7 | *477.7* | 481.3 | 489.0 | 496.0 | *488.8* | 473.0 | 481.8 | 483.7 | *7.4* | *6.7* | *ns* |
| Chlorophyll, SPAD | 47.0 | 46.9 | 47.6 | *47.2* | 48.1 | 49.2 | 50.1 | *49.1* | 49.6 | 51.1 | 51.6 | *50.8* | 48.2 | 49.1 | 49.8 | *0.8* | *0.6* | *ns* |

It has particular increasing effect on the availability of certain nutrients, improving soil structure and increased soil moisture retention and yield under all management conditions (Ragab, 2000; Abdel-Moez, *et al.*, 2001; Shafeek, *et al.*, 2003).

**2. Effect of chicken manure:**

Chicken manure was added for artichoke plants as organic fertilizer at rate of 80, 100 and 120 N kg/fed., and its effect on total and early of head yield as g/plant and/or as number/plant is presented in Table (4). The obtained data reveals that, the total and early yield of artichoke heads increased with increasing the rate of organic manure application, but the differences with addition of chicken manure at rate of 100 and 120 N kg/fed. were not enough to reach the 5% level of significance. It means that, the differences were detected only within addition chicken manure at rate of 80 and that of 100 or 120 N kg/fed. By other mean, from the economic view, it could be concluded that, the most benefit and economic rate addition of chicken manure for artichoke plants at least under the condition of this study is 100 N kg/fed.

From the above mention, it could be summarized that, chicken manure as organic fertilizer plays a great role to increase the total and early artichoke heads as weight (g/plant) and/or number/plant. These results are similar in both 1$^{st}$ and 2$^{nd}$ growing seasons.

It's known that, using organic fertilizer such as chicken manure in soil improves the soil structure. This structural improvement can encourage the plant to have a good root development by improving the aeration in the soil, which lead to higher yield and good quality of artichoke heads.

The results of the before workers on addition of organic manure particularly chicken manure as tool for improving the total and early yield of many vegetables are in good supporting the obtained data (Fatma, 2001; Hassan, 2002; Shafeek, 2003; Shafeek, *et al.*, 2003, Fawzy, *et al.*, 2006).

**3. Effect of the interaction:**

Table (4) presented the total and early yield of artichoke heads as weight (g/plant) and number (No./plant) as well as the mean head weight (g) of total yield in the two experimental seasons as affected by the interaction between agriculture sulphur and chicken manure addition. The statistical analysis of the obtained data reveals that, the differences within different interaction treatments failed to reach the 5% level of significance in both experimental seasons for all characters except the total yield in 1$^{st}$ season. These indicate that, each of the two interaction factors acts independent on the artichoke yield. In spite of no great significant effect among all interaction treatments, it is clear that, the absence of agriculture sulphur resulted in the lowest values of head and its components. It means that, increasing chicken manure addition was more effective in the presence than in the absence of agriculture sulphur. These findings are in good accordance with that which reported by Abdel-Moez, *et al.*, (2001); Shafeek, *et al.*, (2003).

**Table (4): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on artichoke yield and its components in 1st season 2004/2005 and 2nd season 2005/2006.**

| Treatments (A) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | | LSD at 5% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characters (B) | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | A | B | AxB |
| *1st season 2004/2005* | | | | | | | | | | | | | | | | | | |
| Early yield, g/plant | 450.0 | 530.0 | 538.3 | *506.1* | 468.3 | 535.0 | 605.0 | *536.1* | 615.0 | 686.7 | 635.0 | *645.6* | 511.1 | 583.9 | 592.8 | *82.5* | *ns* | *ns* |
| Total yield, g/plant | 1686.7 | 1943.3 | 2206.7 | *1945.6* | 2146.7 | 2360.0 | 2415.0 | *2307.2* | 2400.0 | 2750.0 | 2739.3 | *2629.8* | 2077.8 | 2351.1 | 2453.7 | *326.5* | *178.5* | *309.2* |
| Earlyl yield No./plant | 2.33 | 2.67 | 2.67 | *2.56* | 2.33 | 2.67 | 3.00 | *2.67* | 3.00 | 3.33 | 3.00 | *3.11* | 2.55 | 2.89 | 2.89 | *0.30* | *ns* | *ns* |
| Total yield No./plant | 9.33 | 10.33 | 11.67 | *10.44* | 11.00 | 12.00 | 12.67 | *11.89* | 12.00 | 13.67 | 13.33 | *13.00* | 10.78 | 12.00 | 12.56 | *1.30* | *0.80* | *ns* |
| Mean head weight, g | 180.8 | 188.1 | 189.1 | *186.0* | 195.2 | 196.7 | 190.6 | *194.1* | 200.0 | 201.2 | 205.5 | *202.2* | 192.0 | 195.3 | 195.1 | *4.5* | *ns* | *ns* |
| *2nd season 2005/2006* | | | | | | | | | | | | | | | | | | |
| Early yield, g/plant | 391.7 | 406.7 | 478.3 | *425.6* | 487.0 | 555.7 | 565.0 | *535.9* | 615.0 | 570.0 | 641.7 | *608.9* | 497.9 | 510.8 | 561.7 | *ns* | *ns* | *ns* |
| Total yield, g/plant | 1816.7 | 1873.7 | 2155.3 | *1948.6* | 2202.3 | 2340.7 | 2556.7 | *2366.6* | 2376.7 | 2528.3 | 2678.3 | *2527.8* | 2131.9 | 2247.6 | 2463.4 | *343.0* | *154.0* | *ns* |
| Earlyl yield No./plant | 2.00 | 2.00 | 2.33 | *2.11* | 2.33 | 2.67 | 2.67 | *2.56* | 3.00 | 2.67 | 3.00 | *2.89* | 2.44 | 2.45 | 2.67 | *ns* | *ns* | *ns* |
| Total yield No./plant | 10.00 | 10.00 | 11.00 | *10.33* | 11.67 | 12.00 | 13.00 | *12.22* | 12.33 | 12.67 | 13.33 | *12.78* | 11.33 | 11.56 | 12.44 | *1.60* | *0.80* | *ns* |
| Mean head weight, g | 181.7 | 187.4 | 195.9 | *188.3* | 188.7 | 195.1 | 196.7 | *193.5* | 192.8 | 199.6 | 200.9 | *197.7* | 187.7 | 194.0 | 197.8 | *3.7* | *2.4* | *ns* |

**C. Chemical constituent of leaf tissues:**

**1. Effect of sulphur addition:**

The content of N, P, K, Ca and Fe in leaves tissue at old of 90 and 120 days after planting of artichoke plants in growing seasons of 2004/2005 and 2005/2006 as influenced by the sulphur addition at 3 rates are shown in Table (5). Whereas, only the nitrogen content in leaf tissues was significantly responded by sulphur application in the two experimental seasons, where, the highest nitrogen percentage in artichoke leaf was associated with addition of the highest level of sulphur (300 kg/fed.). These were similar with those plants of 90 and 120 days old. The obtained results of Table (5) show that, the addition of sulphur up to 300 kg/fed. had no significant effect on the leaves content of P, K, Ca and Fe at different plant ages in both growing seasons. It could be summarized that, sulphur addition had no great effect on the elements content of artichoke plants.

It reviews regarding the role of sulphur in rooting media varied. However, many investigators reported that, generally, sulphur increased the capacity of plants to absorb nutrients (Schnug, 1990). This might be attributed to the reduction of soil alkalinity due to the oxidization of S to sulphuric acid. Also, due to lowering the soil pH that lead to an increase of the availability of nutrient elements (El-Maghraby *et al.*, 1997; Abdel-Moez, *et al.*, 2001; Shafeek, 2003).

On the other view, it could be concluded that, the sulphur addition had a little effect on the mineral absorption, where, the efficiency of the element in the soil depends largely on the incubation period which followed the time of application. Thus the degree of decrease in the soil pH was increased by increasing both the rate of sulphur application and the incubation period.

**2. Effect of chicken manure:**

Table (5) shows clearly that, the some nutritional values, i.e. P, K and Fe in leaves tissue of artichoke plants had no significant response to the addition of chicken manure as nitrogen fertilization. These findings are true for the two taken samples (90 and 120 days old) in the two experimental seasons.

Also, the obtained result reveals that, both nitrogen and calcium contents in leaf tissues recorded increments when those plants received higher nitrogen rates above 80 N kg/fed. as chicken manure. These were similar in both growing seasons.

It could be concluded that, the elemental values of leaves tissue, i.e., P, K and Fe recorded no significantly differences within the varied nitrogen fertilizer rates. Generally, in spite of the no statistical obtained results, but the data presented in Table (5) demonstrates that, the values of P, K, and Fe in leaves tissue tended to increase with addition of chicken manure as a nitrogen fertilizer.

The higher values of nutritional elements in leaves of that plant received more chicken manure may be attributed to the enough quantity in rooting zone, consequently more absorption of nutrition.

**Table (5): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on chemical constituent of artichoke leaves in 1st season 2004/2005 and 2nd season 2005/2006.**

| Treatments(A) / Characters (B) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | | LSD at 5% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | A | B | AxB |
| *1st season 2004/2005* | | | | | | | | | | | | | | | | | | |
| *after 90 days from planting* | | | | | | | | | | | | | | | | | | |
| N, % | 3.34 | 3.39 | 3.52 | *3.42* | 3.61 | 3.59 | 3.72 | *3.64* | 3.57 | 3.64 | 3.69 | *3.63* | 3.51 | 3.54 | 3.64 | *0.08* | *0.06* | *ns* |
| P, % | 0.47 | 0.49 | 0.43 | *0.46* | 0.41 | 0.41 | 0.40 | *0.40* | 0.41 | 0.42 | 0.40 | *0.41* | 0.43 | 0.44 | 0.41 | *ns* | *ns* | *ns* |
| K, % | 3.88 | 3.79 | 3.63 | *3.77* | 3.62 | 3.75 | 3.74 | *3.70* | 3.64 | 3.76 | 3.75 | *3.72* | 3.71 | 3.77 | 3.71 | *ns* | *ns* | *ns* |
| Ca, % | 0.95 | 1.15 | 1.14 | *1.08* | 0.96 | 1.00 | 1.15 | *1.04* | 1.18 | 1.13 | 1.21 | *1.17* | 1.03 | 1.09 | 1.17 | *ns* | *0.07* | *0.57* |
| Fe, ppm | 339 | 313 | 397 | *349* | 473 | 536 | 453 | *487* | 523 | 587 | 417 | *509* | 445 | 478 | 422 | *54.0* | *ns* | *85.3* |
| *after 120 days from planting* | | | | | | | | | | | | | | | | | | |
| N, % | 2.92 | 3.11 | 3.15 | *3.06* | 3.02 | 3.13 | 3.30 | *3.15* | 3.00 | 3.22 | 3.29 | *3.17* | 2.98 | 3.15 | 3.25 | *0.07* | *0.08* | *ns* |
| P, % | 0.51 | 0.52 | 0.51 | *0.51* | 0.49 | 0.44 | 0.45 | *0.46* | 0.42 | 0.43 | 0.42 | *0.42* | 0.47 | 0.46 | 0.46 | *ns* | *ns* | *ns* |
| K, % | 3.62 | 3.92 | 3.88 | *3.81* | 3.62 | 3.57 | 3.59 | *3.59* | 3.62 | 3.63 | 3.82 | *3.69* | 3.62 | 3.71 | 3.76 | *ns* | *ns* | *ns* |
| Ca, % | 0.98 | 1.05 | 1.03 | *1.02* | 0.94 | 1.10 | 0.97 | *1.00* | 1.05 | 1.04 | 0.99 | *1.03* | 0.99 | 1.06 | 1.00 | *ns* | *ns* | *ns* |
| Fe, ppm | 251 | 247 | 288 | *262* | 262 | 282 | 247 | *264* | 217 | 237 | 249 | *234* | 243 | 255 | 261 | *ns* | *ns* | *26.8* |
| *2nd season 2005/2006* | | | | | | | | | | | | | | | | | | |
| *after 90 days from planting* | | | | | | | | | | | | | | | | | | |
| N, % | 3.28 | 3.54 | 3.63 | *3.48* | 3.59 | 3.68 | 3.81 | *3.69* | 3.64 | 3.72 | 3.78 | *3.71* | 3.50 | 3.65 | 3.74 | *0.06* | *0.06* | *0.10* |
| P, % | 0.49 | 0.43 | 0.40 | *0.44* | 0.37 | 0.43 | 0.34 | *0.38* | 0.43 | 0.43 | 0.50 | *0.45* | 0.43 | 0.43 | 0.41 | *ns* | *ns* | *ns* |
| K, % | 3.48 | 3.39 | 3.32 | *3.40* | 3.54 | 3.70 | 3.62 | *3.62* | 3.51 | 3.55 | 3.55 | *3.54* | 3.51 | 3.55 | 3.50 | *ns* | *ns* | *ns* |
| Ca, % | 0.94 | 0.98 | 1.06 | *0.99* | 0.80 | 0.84 | 0.97 | *0.87* | 1.04 | 1.01 | 1.00 | *1.02* | 0.93 | 0.94 | 1.01 | *ns* | *ns* | *ns* |
| Fe, ppm | 423 | 379 | 461 | *421* | 466 | 489 | 497 | *484* | 559 | 561 | 400 | *507* | 483 | 476 | 453 | *ns* | *ns* | *84.5* |
| *after 120 days from planting* | | | | | | | | | | | | | | | | | | |
| N, % | 3.08 | 3.17 | 3.22 | *3.16* | 3.16 | 3.22 | 3.34 | *3.24* | 3.24 | 3.35 | 3.31 | *3.30* | 3.16 | 3.25 | 3.29 | *0.06* | *0.07* | *ns* |
| P, % | 0.41 | 0.48 | 0.50 | *0.46* | 0.43 | 0.48 | 0.38 | *0.43* | 0.41 | 0.36 | 0.38 | *0.38* | 0.41 | 0.44 | 0.42 | *ns* | *ns* | *0.08* |
| K, % | 4.08 | 3.97 | 4.00 | *4.02* | 3.98 | 4.05 | 3.90 | *3.98* | 4.10 | 4.03 | 3.96 | *4.03* | 4.05 | 4.02 | 3.95 | *ns* | *ns* | *ns* |
| Ca, % | 0.93 | 1.11 | 1.07 | *1.04* | 0.97 | 1.12 | 1.00 | *1.03* | 1.06 | 1.06 | 1.00 | *1.04* | 0.99 | 1.10 | 1.02 | *ns* | *0.04* | *0.07* |
| Fe, ppm | 287 | 283 | 345 | *305* | 343 | 346 | 261 | *316* | 308 | 261 | 335 | *301* | 312 | 297 | 313 | *ns* | *ns* | *41.4* |

These findings are in good accordance with that which reported by many investigators such as Fatma, 2001; Shafeek, *et al.*, 2003.

**3. Effect of the interactions:**

Treatments of the interaction between addition of agriculture sulphur with chicken manure at different rates and their effects on some nutritional values, i.e. N, P, K, Ca and Fe are shown in Table (5). Whereas, the obtained data shows that, the interaction treatments had no great effect on elemental values to reach the significant level with a little exception. It means that, each factor of the interaction acts independently.

**D. Some physical properties of artichoke yield:**

**1. Effect of sulphur addition:**

Data in Table (6) shows that, the addition of sulphur at different rates, i.e. 150 and/or 300 kg/fed. gained enhancements in the average fresh and dry weight of edible part (receptacle) of artichoke heads as well as the average fresh weight of whole head and its length and diameter. Whereas, the statistical analysis of the obtained data reveals that, the differences within rates of sulphur and control treatment (zero sulphur) were great enough to reach the 5% level of significant. These findings were true in both taken samples, i.e., in early and late harvesting yield of the two experimental seasons, with some exception of the calculated percentage of dry matter content in edible parts in the two samples of both growing seasons, as well as average fresh weight of whole head in early yield sample of the 1$^{st}$ season.

Generally, it could be concluded that, the best physical properties of artichoke head were resulted with that plants which received the highest rate of sulphur (300 kg/fed.).

The fruit is essential physical characteristics which had been most easily and frequently measured are the subjects of our discussion. Indeed, the fruit attribute which had been mainly measured in most attempts were the head length and diameter. However, as a general trend sulphur application improved the head shape by increasing these two margins. The previous investigation regarding role of sulphur to enhance the physical properties of some vegetables are in good agreement with those of that written here (Abdel-Gawad and Mahmoud 1993; Abdel-Moez *et al.* 1997; El-Desuki and Sawan, 2001; Shafeek, *et al.*, 2003).

**2. Effect of chicken manure:**

Application of chicken manure as organic nitrogen fertilizer at rates of 80, 100 and 120 N kg/fed. had a little effect on the physical properties of artichoke heads. These were similar in both taken samples, i.e. early and/or late of the two experimental seasons. Generally, in spite of the no statistical differences within different rates of nitrogen addition, the presented data in Table (6) clearly indicates that, the fresh and dry weight of edible parts as well as the fresh weight and dimension (length and diameter) of whole head, all of them tended to record increases in their values by increasing the addition rate of chicken manure. These mean that, addition chicken manure little improved the physical quality of artichoke head. These were completely similar in both experimental seasons.

**Table (6): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on artichoke head characters in 1st season 2004/2005 and 2nd season 2005/2006.**

| Treatments (A) / Characters (B) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 80 kgN | 100 kgN | 120 kgN | *Mean* | 80 kgN | 100 kgN | 120 kgN | *Mean* | 80 kgN | 100 kgN | 120 kgN | *Mean* | 80 kgN | 100 kgN | 120 kgN |
| *1st season 2004/2005* 1st sample in February 2005 | | | | | | | | | | | | | | | |
| Head fresh weight, g | 192.8 | 198.3 | 201.1 | *197.4* | 200.8 | 198.9 | 201.7 | *200.5* | 205.2 | 205.8 | 213.3 | *208.1* | 199.6 | 201.0 | 205.4 |
| Head length, mm | 80.0 | 80.7 | 81.7 | *80.8* | 80.7 | 81.3 | 83.7 | *81.9* | 81.3 | 83.7 | 84.7 | *83.2* | 80.7 | 81.9 | 83.4 |
| Head diameter, mm | 76.7 | 77.3 | 78.0 | *77.3* | 78.7 | 79.3 | 80.3 | *79.4* | 78.3 | 80.7 | 82.3 | *80.4* | 77.9 | 79.1 | 80.2 |
| Edible part F.W., g | 38.1 | 39.6 | 40.4 | *39.4* | 40.2 | 40.0 | 40.2 | *40.1* | 41.2 | 42.0 | 43.1 | *42.1* | 39.8 | 40.5 | 41.2 |
| Edible part D.W., g | 5.7 | 6.0 | 6.2 | *6.0* | 6.1 | 6.1 | 6.3 | *6.2* | 6.3 | 6.6 | 6.7 | *6.5* | 6.0 | 6.2 | 6.4 |
| 2nd sample in April 2005 | | | | | | | | | | | | | | | |
| Head fresh weight, g | 175.3 | 183.1 | 184.0 | *180.8* | 189.4 | 194.3 | 186.7 | *190.1* | 195.0 | 197.5 | 201.1 | *197.9* | 186.6 | 191.6 | 190.6 |
| Head length, mm | 76.0 | 76.7 | 77.7 | *76.8* | 77.3 | 78.0 | 78.3 | *77.9* | 78.0 | 79.3 | 80.0 | *79.1* | 77.1 | 78.0 | 78.7 |
| Head diameter, mm | 71.7 | 73.0 | 74.0 | *72.9* | 73.3 | 75.0 | 76.0 | *74.8* | 75.0 | 76.0 | 76.7 | *75.9* | 73.3 | 74.7 | 75.6 |
| Edible part F.W., g | 35.0 | 36.2 | 36.4 | *35.9* | 37.2 | 38.4 | 36.9 | *37.5* | 39.0 | 39.5 | 40.1 | *39.5* | 37.1 | 38.0 | 37.8 |
| Edible part D.W., g | 5.4 | 5.7 | 5.7 | *5.6* | 5.8 | 6.0 | 5.8 | *5.9* | 6.0 | 6.2 | 6.2 | *6.1* | 5.7 | 6.0 | 5.9 |
| *2nd season 2005/2006* 1st sample in February 2006 | | | | | | | | | | | | | | | |
| Head fresh weight, g | 195.8 | 203.3 | 205.8 | *201.6* | 208.7 | 208.6 | 211.7 | *209.7* | 205.0 | 213.9 | 215.0 | *211.3* | 203.2 | 208.6 | 210.8 |
| Head length, mm | 81.0 | 82.0 | 82.3 | *81.8* | 82.7 | 83.0 | 84.3 | *83.3* | 83.7 | 84.0 | 85.3 | *84.3* | 82.5 | 83.0 | 84.0 |
| Head diameter, mm | 78.0 | 78.7 | 80.0 | *78.9* | 79.3 | 79.0 | 80.7 | *79.7* | 80.3 | 82.0 | 83.0 | *81.8* | 79.2 | 79.9 | 81.2 |
| Edible part F.W., g | 40.4 | 41.7 | 42.2 | *41.4* | 42.7 | 43.1 | 43.6 | *43.1* | 42.3 | 44.2 | 44.6 | *43.7* | 41.8 | 43.0 | 43.5 |
| Edible part D.W., g | 5.8 | 6.0 | 6.2 | *6.0* | 6.2 | 6.3 | 6.2 | *6.2* | 6.3 | 6.4 | 6.4 | *6.4* | 6.1 | 6.2 | 6.3 |
| 2nd sample in April 2006 | | | | | | | | | | | | | | | |
| Head fresh weight, g | 176.0 | 182.3 | 190.9 | *183.1* | 182.0 | 189.1 | 191.3 | *187.5* | 187.7 | 194.4 | 196.3 | *192.8* | 181.9 | 188.6 | 192.8 |
| Head length, mm | 76.0 | 76.3 | 77.0 | *76.4* | 76.7 | 77.3 | 79.7 | *77.9* | 77.7 | 79.7 | 80.0 | *79.1* | 76.8 | 77.8 | 78.9 |
| Head diameter, mm | 72.3 | 73.7 | 73.7 | *73.2* | 74.7 | 75.3 | 76.0 | *75.3* | 75.3 | 76.3 | 77.3 | *76.3* | 74.1 | 75.1 | 75.7 |
| Edible part F.W., g | 36.0 | 37.4 | 39.2 | *37.5* | 37.5 | 38.8 | 39.4 | *38.6* | 38.5 | 40.0 | 40.3 | *39.6* | 37.3 | 38.7 | 39.6 |
| Edible part D.W., g | 5.4 | 5.7 | 5.8 | *5.6* | 5.7 | 6.0 | 6.2 | *6.0* | 6.0 | 6.1 | 6.2 | *6.1* | 5.7 | 5.9 | 6.1 |

This improvement can encourage the haulm growth with increase the photosynthetic rates leading to an increase of the assimilation rates. So, that head size and number of heads per plant increase, which increased the total yield and its physical properties. The improvement in characters of artichoke yield, which affected by organic manure in this inscript was in good accordance with that reported by (Abdul-Baki, *et al.*, 1997; Caslellanos, *et al.*, 1999; Shafeek, 2003; Shafeek, *et al.*, 2003, Fawzy, *et al.*, 2006).

**3. Effect of the interaction:**

The interaction between chicken manure and sulphur addition at different rates resulted in no significant effect on the fresh and dry weight of edible parts as well as fresh weight, length and diameter of whole artichoke head (Table 6). These results were true in the two taken samples, i.e., early and late of the two experimental seasons. These mean that, each of the two factors of interaction acts independently.

**E. Some chemical properties of artichoke yield:**

**1. Effect of sulphur addition:**

The obtained data Table (7) clearly indicates that, the sulphur addition at rates of 150 and 300 kg/fed. gained a little effect on the content of P, K, Ca, Fe and fibers in heads tissue of artichoke yield. In spite of the no significant differences within treatments, it is clear that, the sulphur treatments gained some increases in chemical constituents of artichoke heads, with exception of the total fiber, where, it tended to decrease with more sulphur addition. Only the content of nitrogen and crude protein gradually increased in edible part of artichoke heads with increasing the addition rates of agriculture sulphur. These results were in accordance with those of Shafeek, *et al.*, (2003) on Japanese radish.

**2. Effect of chicken manure:**

Table (7) indicates that, nitrogen addition as a chicken manure for artichoke plants had favourable effect on the chemical properties of heads which harvested early (in February) and/or late (in April) of the two experimental seasons. Whereas, with increasing the application rate of chicken manure up to 120 kg/fed., obtained an increase in values of N, K, Ca, and crude protein in artichoke head tissues. On the contrary, P, Fe and total fibers, its values tended to decrease with the increasing rate of nitrogen addition as chicken manure. These results were similar in both taken samples (early, and/or late) of the two experimental seasons.

The favourable effect of chicken manure on some chemical constituents of artichoke heads may be interpreted as organic materials contain. Considerable amounts of micro and macro nutrients that can contribute to improve fruit quality of grown plants. Many investigators had a similar results which obtained here such as Abdalla, *et al.*, 2001; Fatma, 2001; Fatma, 2002; Shafeek, 2003.

**3. Effect of the interaction:**

The results of some chemical properties (N, P, K, Ca, Fe, crude protein and total fibers) of the edible parts of artichoke head as affected by the various treatments of agriculture sulphur and chicken manure in the growing seasons of 2004/2005 and 2005/2006 are presented in Table (7).

**Table (7): Effect of different levels of agricultural sulfur and organic nitrogen as chicken manure on chemical constituent of artichoke edible parts (receptacle) in 1st season 2004/2005 and 2nd season 2005/2006.**

| Treatments(A) | 0 kg Sulfur | | | | 150 kg Sulfur | | | | 300 kg Sulfur | | | | Mean | | | LSD at 5% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characters (B) | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | Mean | 80 kgN | 100 kgN | 120 kgN | A | B | AxB |
| *1st season 2004/2005* | | | | | | | | | | | | | | | | | | |
| *Main head in February* | | | | | | | | | | | | | | | | | | |
| N, % | 2.95 | 3.13 | 3.09 | *3.06* | 3.01 | 3.17 | 3.24 | *3.14* | 3.07 | 3.28 | 3.20 | *3.18* | 3.01 | 3.19 | 3.18 | *0.06* | *0.06* | *ns* |
| P, % | 0.45 | 0.49 | 0.50 | *0.48* | 0.51 | 0.52 | 0.48 | *0.50* | 0.49 | 0.37 | 0.42 | *0.42* | 0.48 | 0.46 | 0.47 | *ns* | *ns* | *ns* |
| K, % | 3.00 | 3.09 | 2.96 | *3.02* | 2.92 | 3.18 | 3.24 | *3.11* | 2.95 | 3.12 | 3.38 | *3.15* | 2.96 | 3.13 | 3.19 | *ns* | *0.12* | *0.21* |
| Ca, % | 0.45 | 0.53 | 0.43 | *0.47* | 0.41 | 0.47 | 0.47 | *0.45* | 0.51 | 0.52 | 0.59 | *0.54* | 0.46 | 0.51 | 0.50 | *0.07* | *0.04* | *0.06* |
| Fe, ppm | 115 | 110 | 109 | *111* | 106 | 97 | 82 | *95* | 90 | 88 | 94 | *91* | 103 | 98 | 95 | *ns* | *ns* | *ns* |
| Crude protein, % | 18.46 | 19.54 | 19.33 | *19.11* | 18.81 | 19.81 | 20.25 | *19.62* | 19.21 | 20.48 | 20.00 | *19.90* | 18.83 | 19.94 | 19.86 | *0.39* | *0.39* | *ns* |
| Total fibers, % | 14.07 | 13.97 | 13.45 | *13.83* | 14.04 | 13.72 | 13.60 | *13.79* | 13.80 | 13.51 | 13.23 | *13.51* | 13.97 | 13.73 | 13.43 | *ns* | *0.20* | *ns* |
| *Secondary head in April* | | | | | | | | | | | | | | | | | | |
| N, % | 2.38 | 2.49 | 2.54 | *2.47* | 2.61 | 2.73 | 2.70 | *2.68* | 2.59 | 2.68 | 2.79 | *2.69* | 2.53 | 2.63 | 2.68 | *0.08* | *0.08* | *ns* |
| P, % | 0.43 | 0.39 | 0.45 | *0.42* | 0.42 | 0.49 | 0.47 | *0.46* | 0.55 | 0.43 | 0.45 | *0.48* | 0.47 | 0.44 | 0.46 | *ns* | *ns* | *0.08* |
| K, % | 3.32 | 3.42 | 3.67 | *3.47* | 3.35 | 3.25 | 3.26 | *3.29* | 3.18 | 3.09 | 3.32 | *3.20* | 3.28 | 3.25 | 3.42 | *ns* | *0.12* | *ns* |
| Ca, % | 0.60 | 0.54 | 0.49 | *0.54* | 0.49 | 0.51 | 0.53 | *0.51* | 0.50 | 0.54 | 0.55 | *0.53* | 0.53 | 0.53 | 0.52 | *ns* | *ns* | *ns* |
| Fe, ppm | 83 | 87 | 82 | *84* | 87 | 92 | 83 | *87* | 91 | 86 | 86 | *88* | 87 | 88 | 83 | *ns* | *ns* | *ns* |
| Crude protein, % | 14.90 | 15.56 | 15.90 | *15.45* | 16.33 | 17.08 | 16.85 | *16.75* | 16.19 | 16.77 | 17.44 | *16.80* | 15.81 | 16.47 | 16.73 | *0.52* | *0.47* | *ns* |
| Total fibers, % | 14.36 | 14.10 | 13.82 | *14.09* | 14.14 | 14.15 | 13.93 | *14.07* | 14.07 | 13.99 | 13.83 | *13.96* | 14.19 | 14.08 | 13.86 | *0.11* | *0.19* | *ns* |
| *2nd season 2005/2006* | | | | | | | | | | | | | | | | | | |
| *Main head in February* | | | | | | | | | | | | | | | | | | |
| N, % | 2.68 | 2.87 | 2.96 | *2.84* | 2.85 | 2.98 | 3.06 | *2.96* | 2.97 | 3.12 | 3.20 | *3.10* | 2.83 | 2.99 | 3.07 | *0.07* | *0.05* | *ns* |
| P, % | 0.39 | 0.40 | 0.40 | *0.40* | 0.43 | 0.46 | 0.42 | *0.44* | 0.43 | 0.45 | 0.38 | *0.42* | 0.42 | 0.44 | 0.40 | *ns* | *ns* | *ns* |
| K, % | 2.84 | 2.88 | 2.75 | *2.82* | 2.96 | 2.90 | 2.95 | *2.94* | 2.94 | 2.93 | 3.20 | *3.02* | 2.91 | 2.90 | 2.97 | *0.05* | *ns* | *0.16* |
| Ca, % | 0.51 | 0.65 | 0.59 | *0.58* | 0.60 | 0.62 | 0.59 | *0.60* | 0.54 | 0.48 | 0.60 | *0.54* | 0.55 | 0.58 | 0.59 | *ns* | *0.03* | *0.05* |
| Fe, ppm | 103 | 87 | 81 | *90* | 90 | 88 | 123 | *100* | 118 | 106 | 102 | *108* | 104 | 93 | 102 | *ns* | *ns* | *ns* |
| Crude protein, % | 16.77 | 17.94 | 18.50 | *17.74* | 17.79 | 18.63 | 19.15 | *18.52* | 18.54 | 19.50 | 20.33 | *19.46* | 17.70 | 18.69 | 19.33 | *0.41* | *0.32* | *ns* |
| Total fiber, % | 14.19 | 14.03 | 13.68 | *13.97* | 14.21 | 13.98 | 13.87 | *14.02* | 14.11 | 13.93 | 13.53 | *13.86* | 14.17 | 13.98 | 13.69 | *0.08* | *0.17* | *ns* |
| *Secondary head in April* | | | | | | | | | | | | | | | | | | |
| N, % | 2.34 | 2.46 | 2.49 | *2.43* | 2.42 | 2.57 | 2.66 | *2.55* | 2.47 | 2.59 | 2.71 | *2.59* | 2.41 | 2.54 | 2.62 | *0.06* | *0.06* | *ns* |
| P, % | 0.38 | 0.44 | 0.35 | *0.39* | 0.41 | 0.43 | 0.47 | *0.44* | 0.46 | 0.47 | 0.43 | *0.46* | 0.42 | 0.45 | 0.42 | *ns* | *ns* | *ns* |
| K, % | 2.99 | 3.00 | 3.05 | *3.01* | 2.93 | 3.01 | 2.88 | *2.94* | 2.97 | 3.14 | 3.20 | *3.10* | 2.96 | 3.05 | 3.04 | *ns* | *ns* | *ns* |
| Ca, % | 0.53 | 0.55 | 0.52 | *0.53* | 0.51 | 0.46 | 0.46 | *0.48* | 0.45 | 0.47 | 0.50 | *0.47* | 0.50 | 0.49 | 0.49 | *ns* | *ns* | *ns* |
| Fe, ppm | 85 | 82 | 88 | *85* | 81 | 86 | 81 | *82* | 110 | 104 | 94 | *102* | 92 | 90 | 88 | *ns* | *ns* | *ns* |
| Crude protein, % | 14.63 | 15.35 | 15.54 | *15.17* | 15.13 | 16.06 | 16.65 | *15.95* | 15.46 | 16.21 | 16.96 | *16.21* | 15.07 | 15.87 | 16.38 | *0.40* | *0.40* | *ns* |
| Total fiber, % | 14.21 | 14.15 | 14.02 | *14.13* | 14.06 | 13.89 | 13.70 | *13.88* | 14.12 | 13.90 | 13.67 | *13.90* | 14.13 | 13.98 | 13.80 | *0.15* | *0.16* | *ns* |

The statistical analysis of the obtained data reveals that, the differences within different interaction treatments regarding the content of N, P, K, Ca, Fe, crude protein and total fibers were not great enough to be significant. These results are going in the same trend in the two taken samples (early and/or late) of the two investigated seasons, with some exception. In generally, data of 2nd season shows identical trend to those of the 1st season.

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## استجابة نباتات الخرشوف للتسميد بالكبريت الزراعي وسماد الدواجن

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**[1] قسم تكنولوجيا الحاصلات البستانية – المركز القومى للبحوث – الدقى – القاهرة – مصر**

**[2] قسم بحوث الخضر – المركز القومى للبحوث – الدقى – القاهرة – مصر**

أقيمت تجربتان حقليتان بالأراضى الجديدة بالنوبارية بمحافظة البحيرة خلال موسمى الزراعة ٢٠٠٤/٢٠٠٥ ، ٢٠٠٥/٢٠٠٦ وذلك لدراسة استجابة نباتات الخرشوف (الصنف الفرنساوى) لثلاثة معدلات مختلفة من الكبريت الزراعى (صفر، ١٥٠ و ٣٠٠ كجم/فدان) وثلاثة معدلات مختلفة من النتروجين (٨٠، ١٠٠ و ١٢٠ كجم/فدان) مضافة من مصدر عضوى وهو سماد الكتكوت المحتوى على ٣,٤% نيتروجين. تم تسجيل بيانات النمو الخضرى ومحصول النورات وجودتها وكذلك محتوى النبات من العناصر الغذائية، وكانت أهم النتائج مايلى:

- اضافة الكبريت الزراعى بأعلى معدلاته (٣٠٠ كجم/فدان) أدى لزيادة كل صفات النمو الخضرى (ارتفاع النبات، عدد أوراق النبات، الوزن الغض والجاف للورقة الرابعة ومساحتها الورقية) و محتوى الأوراق من الكلوروفيل الكلى و كذلك محصول النورات وجودتها، فى حين أن محتوى الأوراق والجزء الصالح للأكل (التخت النورى) لنبات الخرشوف من العناصر الغذائية (نتروجين، فوسفور، بوتاسيوم، كالسيوم وحديد) زاد ولكن بدرجة غير معنوية.
- ازداد النمو الخضرى (ارتفاع النبات، عدد أوراق النبات، الوزن الغض والجاف للورقة الرابعة ومساحتها الورقية) و محتوى الأوراق من الكلوروفيل الكلى و كذلك محصول النورات وجودتها بزيادة معدل اضافة سماد الكتكوت من ٨٠ كجم حتى ١٢٠ كجم نتروجين/فدان، فى حين لم يتأثر محتوى النبات من العناصر الغذائية (نتروجين، فوسفور، بوتاسيوم، كالسيوم وحديد) بدرجة كبيرة.
- غالبا لم يكن هناك تأثير معنوى لمعاملات التفاعل بين معدلات كل من الكبريت الزراعى وسماد الكتكوت على نمو وانتاجية نباتات الخرشوف وجودة النورات الزهرية، على الرغم من أن أعلى القيم لمعظم القياسات التى درست كان مرتبط بأعلى معدل اضافة من الكبريت الزراعى (٣٠٠ كجم/فدان) وسماد الكتكوت (١٢٠ كجم نتروجين/فدان).
- من الناحية الاقتصادية يمكننا التوصية باستخدام المعدلات المتوسطة من الكبريت الزراعى (١٥٠ كجم/فدان) وسماد الكتكوت (١٠٠ كجم نتروجين/فدان) فى تسميد نباتات الخرشوف.