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EFFECT OF DIFFERENT LEVELS OF SULPHUR ON TRAITS AND YIELD OF CUCUMBER PLANTS GROWN UNDER PLASTIC HOUSE CONDITION

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ABSTRACT

Two field experiments were carried out during two successive seasons of 2003 and 2004 at Sakha protected cultivation Site, Kafr El-Sheikh Governorate, to investigate the effect of some sulphur treatments on vegetative traits, productivity and fruit quality of cucumber plants. The obtained results could be summarized as follows:

Application of sulphur with 170 g/m^2 to the plastic house caused a significant increase in the stem length, number of branches and leaves plant, leaf area, chlorophyll content, fresh and dry weight and total yield of fruits. It's also improved fruit quality; i.e. fruit length diameter, dry matter percent, T.S.S.% and shape index. The sulphur addition with 170 g/ m^2 (plastic house) achieved the maximum mean values of vegetative traits characters, total fruit yield, number of fruits plant and shape index control plants without sulphur addition had the lowest values of all studied traits.

INTRODUCTION

Cucumber is generally enlisted as classical commodity for both local consumption and exportation. It is considered one of the most important vegetables which have a great success in the protected cultivation. As might be expected with crops of such promising potentialities efforts to improve its production should be carried out. Among the improvement possibilities, the nutritional requirements play a major role. Although high cost of fertilizers and their recurring shortage in the developing countries have been the greatest constraints experienced by the farmers. Sulphur is a major essential element required for physiological mechanisms of plant traits. Because of the alkalinity of some soils in several regions, most of the added nutritional elements, particularly P, will be unavailable for plants. The addition of sulphur reduces soil pH due to increasing the availability of the nutritional elements. Effect of N, P and K as a mixture as well as sulphur on the physiological processes of plants were studied by many investigators among them *Bakry et al., (1984)* on pea, *Shaheen, (1989)* on squash, *Ogbadu and Easmon (1989)* on eggplant. On the other hand, many investigators studied the role of sulphur on the traits and yield of plants, such as *Kazim, (1984) on pea; Shaheen et al., (1989 b)* on sweet pepper, *Omar et al., (1990)* on pea *Lopez et al., (1994) and Rahman and Hoque, (1994)* on eggplant. Several investigators studied the importance of sulphur addition to alkaline soils, which have been transformed by soil micro organisms to sulphuric acid and reduces pH of soil and improves its properties as well as increases the availability of most nutrients and compounds to plants *(Hilal and Abd El-Fattah, 1987)*. Sulphur addition was found also to improve productivity of plants *(Anonymous, 1986)* and increase uptake of sulphur and other nutrients like N, P, K Fe, Mn and Zn by plants *(Savvas and Lenz, 1995 and Hegde, 1997)*.

Addition of sulphur as soil dressing caused a significant increase in plant height, no significant increase in number of leaves/plant, dry weight of whole plant, leaves and branches. They added that with increasing the level of sulphur addition, the phosphorus and potassium percentages in leaf tissues were increased, while nitrogen percentage decreased. The total fruit yield recorded an increase when sulphur was added at 200 kgs/fed compared with the control treatments. This increase amounted to 18.4% (*Sawan and Rizk, 1998)*. Also, application of sulphur at rate of one ton/fed in combination with 2% orthophosphonc acid treatment gave the best results in traits characters, total yield, dry matter (%) and mineral content (N, K and Fe) of eggplant. P content was increased with treatments including orthophosphoric acid application alone or combined with sulphur addition *(Mohmoud, 1999)*.

The aim of this work was to study the effect of different levels of sulphur application on the vegetative traits, fruits productivity and quality of cucumber plants under plastic houses conditions

MATERIAL AND METHODS

Two field experiments were conducted during the two successive spring seasons of 2003 and 2004 at Sakha Protected Cultivation Sit, Kafr El-Sheikh Governorate to study the impact of the addition of different levels of sulphur on the vegetative traits, productivity and quality of fruits. The experiment soil was characterized as clay containing 37.8% clay, 29.8 silt and 32.4% sand. The pH was 7.6 and Ec was 3.32 m.mhos/cm. The physical and chemical properties of the experimental soil were carried out according to the standard methods that outlined by ***Black, (1983)*** and ***Westerman,(1990)*** and the data are listed in Table 1.

Table 1: Analysis of the tested soil

Soil properties	2003 season	2004 season
Mechanical analysis:		
Sand, %	32.4	33.4
Silt, %	29.8	28.2
Clay, %	37.8	38.4
Texture	Clay	Clay
Chemical analysis:		
$CaCo_3$, %	1.7	2
Organic matter	3.11	2.86
Total nitrogen, %	0.156	0.143
Soil concentration, ppm	2125	2285
Ec, mmhos/cm	3.32	3.57
pH,	7.60	7.9
Soluble N, (mg/100 g)	34	32
Soluble P, (mg/100 g)	1.4	1.3
Soluble K, (mg/100 g)	17	16

Experimental included five treatments which four different levels of sulphur in addition to Zero-sulphur treatment as controls as follows:

1. No-sulphur as control.
2. Addition of 57 g sulphur per m^2.
3. Addition of 114 g sulphur per m^2.
4. Addition of 142 g sulphur per m^2.
5. Addition of 170 g sulphur per m^2.

The experimental design was a complete randomized block design with four replicates. The different elemental sulphur levels were applied during soil preparation. Experimental plot area was 10 m^2 plots, its area of them was 200 m^2. Seeds were sown of on 15th of January of 2003 and 2004 in foam seedling.

Cucumber seedlings were transplanted on 13th of February in both experimental seasons. Double rows have been planted on each bed with a distance of 50 cm between rows and 50 cm between plants within the row. The plastic house was divided into ten raised beds for cultivation, each of them has 100 cm wide, 20 cm height and 50 cm apart. The normal cultural practices; i.e., irrigation, fertilization, pest and disease control of cucumber were carried out according to the recommendations of Sakha Protected Cultivation Site, Ministry of Agriculture, Egypt.

The vegetative traits characteristics of cucumber plants have been measured and recorded after 80 days from the transplanting by using five plants per replicate. Stem length (from the ground surface to the top of the plant), number of branches plant, number of leaves/plant and chlorophyll (a), chlorophyll (b) and total chlorophyll were determined. Chlorophyll content in leaves were estimated in the fifth leaf from the growing tip of 10 plants by means of a spectrophotometer by using N, N- dimethyl formamide according to the methods of *Moran and Porath (1980) and Moran (1982).*

Cucumber fruits were harvested successively at regular intervals of two days over 10 weeks period, weight and number of fruits per plant were determined. The sum of all pickings were expressed as total fruit yield (kg/m^2). A random sample of 5 fruits was taken from each replicate to measure both of fruit length and diameter, dry matter (%), total soluble solids (T.S.S., %) and shape index. The data of two experiments were subjected to statistical analysis of variance according to procedures of *Snedecor and Cochran (1980).*

RESULTS AND DISCUSSION

1-Effect of sulphur application on vegetative traits:

Vegetative traits characters of cucumber plants as affected by the addition of sulphur element at different rates are shown in Table 2. Stem length, number of branches and leaves per plant, were increased gradually with increasing the applied sulphur up to 57 g/m^2 during the two successive seasons of 2003 and 2004 respectively. In the other words, the highest values of vegetative traits characters of cucumber plants were associated with addition of the highest level of sulphur (170 g/m^2). These findings were

significantly true in both experimental seasons. Increasing in stem length and number of leaves plant as a result to adding 170 g sulphur compared with the control treatment (zero sulphur addition) for the agricultural season of 2003, respectively, were significantly true in both seasons. These findings are in agreement with that obtained by *Shaheen et al., (1989)*, who reported that sulphur increased the capacity of the plant in building metabolites. The rate of sulphur addition depends upon the type of soil, pH value, electrical conductivity of soil, type of crop and other many reasons. These points were studied by many investigators, who reported that, adding sulphur to soil caused an increase in traits parameters of plant *(Shaheen et al., 1989a & b* on broad bean and sweet peppers; *Omar et al., 1990* on pea and *Rahman and Hoque 1994* on eggplant. Also, *Heter, (198)* reported that the addition of sulphur decreased pH value of soil extract and expected to increase the availability of many elements in rooting zone, consequently their absorption by plants will be increased. *El-leboudi and Omar 1975* on tomato and *Niranjana and Devi (1990)* on sweet pepper studied the relationship between sulphur application and the content of N, P and K in tissues of leaves, they found a positive relation between them.

Table (2): Effect of the different rates of agricultural Sulphur on the vegetative growth characters of cucumber plants during 2003 and 2004 seasons

Sulphur Treatments	Stem length, cm		No. of branches/plant		No. of leaves/plant	
	2003	2004	2003	2004	2003	2004
No-sulphur	260.3	238.8	3.20	2.03	39.92	36.36
57 g sulpur/m^2	286.8	259.3	4.78	4.35	43.67	40.07
114 g sulpur/m^2	300.8	272.7	5.03	4.87	50.67	43.50
142 g sulpur/m^2	320.7	281.7	4.50	5.20	54.80	46.50
170 g sulpur/m^2	336.0	266.7	6.00	6.00	57.50	51.50
L.S.D 0.05	3.6	4.64	0.62	1.13	3.80	2.96

On the other side, the statistical analysis of the obtained data reveals that there are significant differences between the four levels of sulphur addition. Generally the highest mean values of vegetative traits characters of cucumber were recorded with 170 g sulphur addition followed by 142, 114 and 57 g/m^2 but, the control treatment (zero sulphur addition) attains the mean values of the vegetative traits characters. Also, the obtained values of the vegetative traits characters were higher during the first season of 2003 compared with the second season 2004. This may be attributed to decrease the pH value and Ec value and increase the soluble N, P and K contents during the season 2003 compared with the another season.

2-Effect of sulphur application on cucumber yield:

Adding sulphur to cucumber plants at different rates from zero to 170 g/m^2 had a significant effect on the total fruits yield and number of fruits for

the two seasons. It can be noticed that the control treatment (zero sulphur application) gave the lowest yield as well as the lowest fruits number per plant. On the contrary, the highest yield was recorded with plants supplied with the highest rate of sulphur. Whereas, the difference between addition of low rate (57 g/m^2) and that the highest rate of sulphur was significant. In addition, the obtained data reveal that the difference within addition of any rate of sulphur and that of control (without sulphur addition) had also significant effect on the yield and number of fruits per plant.

Many workers studied the effect of sulphur on yield of many plants and reported that sulphur caused an increase in yield of sweet pepper (*Shaheen et al., 1989b*), pea *(Omar et al., 1990)* and *Rahman and Hoque, 1994).* Whereas, *Shaheen et al., (1989b)* on sweet pepper showed that application of sulphur at various levels enhanced the production of more fruits if compared with the untreated plants. Sulphur application to the soil has been recently introduced as a long term fertilizer. It has a particular increasing effect on the availability of increased soil moisture retention and yield under all management conditions *(Hassaneen, 1992 and Abd El-Moez et al., 1997).*

Generally, it is evident from the data listed in Table 3 that the highest mean values of cucumber yield (13.03 kg/m^2) and fruits number (129.5 fruits/m^2) were a accomplished with application of sulphur with 170 g/ m^2 followed by 142, 114 and 57 g/ m^2 but, the 4.2 kg/m^2 were achieved with the control treatment (without sulphur application).

Table (3): Effect of the different rates of agricultural Sulphur on the fruits yield and number of fruits in 2003 and 2004 seasons

Sulphur Treatments	Yield. (kg/plant)		Yield. (kg/m^2)		No. of fruits/plant		No. of fruits/m^2	
	2003	2004	2003	2004	2003	2004	2003	2004
No-sulphur	1.63	1.24	4.2	3.10	19.35	12.75	48.38	31.86
57 g sulpur/m^2	2.31	1.63	5.78	4.08	28.45	19.19	73.63	47.98
114 g sulpur/m^2	3.10	2.06	7.75	5.15	40.11	26.5	100.28	66.25
142 g sulpur/m^2	3.82	2.50	9.55	6.25	41.25	31.5	103.13	78.75
170 g sulpur/m^2	4.50	3.07	11.25	7.68	51.80	42.1	129.50	105.25
L.S.D 0.05	0.66	0.309	2.043	1.276	10.06	6.14	9.14	9.12

3-Effect of sulphur application on the fruits quality:

As shown in Table 4 sulphur addition at rate up to 57g/m^2 caused increase in the values of fruit length and diameter, dry matter (%) and total soluble solids (T.S.S) in both seasons of 2003 and 2004. The highest values of these properties were recorded with the sulphur application rate of 170 g/m^2 but, the lowest values of them had been obtained with the control treatment (without sulphur addition). Statistical analysis of the obtained data showed that there was significant effect on values of fruit length and diameter, dry matter (%) and T.S.S % but, there were no significant effect on the shape index in both seasons.

Table (4): Effect of different rates of agricultural sulphur on fruit quality of cucumber plants during 2003 and 2004 seasons

Sulphur Treatments	Fruit length (cm)		Fruit diameter (cm)		Shape index		Dry matter (%)		TSS%	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
No-sulphur	17.12	16.81	4.50	4.38	3.80	3.84	3.89	3.51	3.80	3.63
57 gms sulpur/m^2	16.34	16.11	4.15	3.88	3.94	3.84	3.62	3.78	4.11	4.00
114 gms sulpur/m^2	15.52	15.25	3.75	3.69	4.14	4.13	4.25	4.08	4.66	4.33
142 gms sulpur/m^2	14.85	14.30	3.45	3.35	4.30	4.27	4.63	4.46	5.00	4.83
170 gms sulpur/m^2	14.20	13.80	3.18	3.02	4.70	4.57	4.92	4.75	5.42	5.17
L.S.D 0.05	0.612	0.42	0.26	0.18	0.112	0.123	0.24	0.125	0.305	0.780

Sulphur application is considered a very important factor in lowering the soil pH and in increasing the availability of nutrient elements especially P through increasing the rate of solubility of many other components *(Abd El-Moez et al., 2001)*. Therefore, the efficiency of this element in the soil depend 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 rate of sulphur application and incubation period. Consequently, this decrease in the pH value by sulphur application led to increase the solubility and availability of macro elements and microelements and therefore increases the plant uptake of these nutrients *(Dawood et al., 1985)*. The effect of sulphur addition on the nutritional values were studied by other investigators such as *El-Maghraby et al., (1997), Kallil. (1997)* and *Abd El-Moez et al., (2001)*.

4-Effect of sulphur application on the total chlorophyll:

Tabulated data (Table 5) clearly demonstrated that adding sulphur for cucumber plants resulted a superiority in chlorophyll a, b and total chlorophyll if compared to the no addition treatment. Moreover, the average values of chlorophyll a, b and total chlorophyll recorded gradual and constant increases in their values with increasing the rate of sulphur addition in range of zero up to 170 g/m^2.

Table (5): Effect of the different rates of agricultural Sulphur on the chlorophyll content

Sulphur Treatments	Chl. (a) µ/cm^2		Chl. (b) µ/cm^2		Total Chl. µ/cm^2	
	2003	2004	2003	2004	2003	2004
No-sulphur	36.30	35.35	10.17	8.11	55.25	52.63
57 gms sulpur/m^2	40.47	39.28	12.27	9.36	60.73	56.93
114 gms sulpur/m^2	43.97	42.35	13.33	10.97	65.89	59.20
142 gms sulpur/m^2	46.16	45.80	14.25	12.15	71.83	63.30
170 gms sulpur/m^2	51.89	48.45	15.60	13.57	78.27	67.20
L.S.D 0.05	2.52	2.16	1.021	0.926	5.65	3.194

Whereas, the statistical analysis of the obtained data revealed that the differences within different sulphur rates were significantly with average chlorophyll a, b and total chlorophyll. These findings were true in both

experimental seasons. However, the sulphur application rate of 170 g/m^2 gave the maximum value of chlorophyll a (10.8 M/cm^2), chlorophyll b (15.6 M/cm^2) and total chlorophyll(78.27 M/cm^2) during the first season 2003, but the lowest mean values of this characters were obtained with the control treatment (no sulphur addition). This trend may be due to increase with absorption of macro and micro elements with increasing the sulphur rates consequently, increase the chlorophyll content of leaves.

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تأثير إضافة مستويات مختلفة من الكبريت الزراعي على النمو والإنتاجية لمحصول الخيار تحت ظروف الصوب البلاستيكية

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أجريت تجربتان حقليتان فى الصوب الزراعية – بموقع الزراعة المحمية بسخا – محافظة كفر الشيخ خلال الموسمين الزراعيين ٢٠٠٣ ، ٢٠٠٤م وذلك لدراسة تأثير معدلات إضافة عنصر الكبريت (صفر، ٥٧ ، ١١٤ ، ١٤٢ ، ١٧٠ جم/ م^{٢}) على النمو الخضري وصفات الجودة والإنتاجية لمحصول الخيار وقد صممت التجربة بنظام القطاعات الكاملة العشوائية فى أربع مكررات.

وكانت أهم نتائج هذه الدراسة الآتي:

١- أظهرت النتائج أن إضافة الكبريت بمعدل ١٧٠ جم/م^{٢} أعطى أفضل النتائج من حيث صفات النمو الخضري المتمثلة فى طول النبات (٣٣٦ سم) ، عدد الأفرع الثمرية (٦,٦ فرع/نبات) ، عدد الأوراق (٦,٨ ورقة/نبات) ، والمحصول الكلى لنبات الخيار (٥,٢١ كجم/نبات) وعدد الثمار (٥١,٨ ثمرة/نبات) وخصائص جودة الثمار المتمثلة فى طول الثمرة (١٧,١٢ سم) ، قطر الثمرة (٤,٥ سم) ، نسبة المادة الجافة (٤,٩٢%) ، قطر الثمرة (٤,٥ سم) ، نسبة المادة الجافة (٤,٩٢%) ، نسبة المواد الصلبة الذائبة (٥,٤٢%) مقارنة بمعدلات الإضافة الأخرى.

٢- بينت النتائج أن أقل القيم لكل من صفات النمو الخضري والإنتاجية والجودة لمحصول الخيار تم الحصول عليها مع المعاملة الكنترول (بدون إضافة عنصر الكبريت خلال الموسمين الزراعيين وأن هناك زيادة معنوية مضطردة فى قيم المحصول الكلى للثمار والكلوروفيل وجودة الثمار مع زيادة معدل الإضافة من عنصر الكبريت. قد اتضح من الدراسة أن أفضل النتائج من حيث المتغيرات السابقة سجلت فى الموسم الزراعي الأول ٢٠٠٣م مقارنة بالموسم الزراعي الثاني ٢٠٠٤م وذلك مع جميع معدلات الكبريت المختلفة ويرجع ذلك إلى خصوبة التربة بالعناصر الغذائية ونقص رقم الحموضة والتوصيل الكهربائي للتربة فى العام الأول مقارنة بالثاني.