Minufiya J. Agric. Res. Vol.35 No.3:1147-1163(2010) "http://agri.menofia.edu.eg/megla.html"

RESPONSE OF ONION PLANTS GROWN ON CLAYEY SOIL TO ADDITION OF ELEMENTAL SULPHUR AND FOLIAR SPRAY WITH COPPER

M.M. El-Shouny, S. A .El- Shikha and S.F. El-Fiki
Soil, Water and Environment Res. Inst., Agric. Res. Center, Giza, Egypt
(Received: Apr. 11 , 2010)

ABSTRACT: ***A field experiment was conducted at Kafer El-Akram Village, Quessna region, Menufiya Governorate during the two successive winter seasons of 2007/2008 and 2008/2009 to study the effect of elemental sulphur as soil application at levels of 0, 0.5 and 1.0 ton/fed and copper as foliar spray at 60 and 75 days from transplation of onion (Allium cepa L., cv. Giza 20) at rates of 0, 100, 200 and 300 mg Cu/L. and their interaction on growth parameters (plant height, neck or bulb diameter and dry weight of onion bulb after 100 days of transplanting), bulb yield, its quality, nutrient contents and storability of onion.***

The obtained results indicated that:

- The application of sulphur at different levels resulted in a slighty decrease in soil pH, soluble mono cations and anions (Na^+, K^+, Cl^- and HCO^-_3). On the contrary, the values organic matter, EC, soluble dications and anions (Ca^{++}, Mg^{++} and $SO^=_4$) and available N,P and K were increased.

- The addition application of sulphur and copper at different levels significantly increased all growth parameters after 100 days of transplanting, bulb yield, mineral content and storability of onion plants in this investigation.

- Generally, application of 1.0 ton S/fed with spray onion plants by 300 mg Cu/L remarkably enhanced yield quality, mineral content and storability values of onion bulb, likewise physical and chemical properties of experimental soil.

Key words: ***Onion plants, Sulphur application, Cu-Foliar spraying, bulb yield, Nutrients uptake.***

INTRODUCTION

Onion (*Allium cepa* L) is one of the oldest and the most important vegetable crops, due to high income and its great consumption popularity. Also, has enormous nutritional and medical values because of its contents of carbohydrates, proteins, vitamins, minerals and antioxidant substances (Paul and Southgate, 1987). Moreover, the successful fertilization strategy aims to supply the growing crop with its need of nutrients at suitable time, place and dose.

Application of sulphur to the soil has a several effects; such as, reducing soil pH, improving soil-water relation and increasing availability of nutrients

(Marschner, 1998). Addition of sulphur to an alkaline soil plays an important role not only as a chemical amelioration, but also as a fertilizer (Rajas *et al.,* 1993; El-Shafie and El-Gamaily, 2002, Fathi *et al.,* 2003 and Nassar *et al.,* 2006). This in fact due to that S is essential for the synthesis of certain amino acids and vitamins. Sulphur is also presented in some coenzymes including biotin, thiamin and coenzyme A, which are essential for metabolism (Mohammed and Kandeel, 1998 and Nassar *et al.,* 2006).

Foliar fertilization with soluble nutrients or chelates micronutrients is more efficient and economic than soil fertilization, especially for vegetable crops. Alexander (1986) summarized the advantage of foliar spraying of plant nutrients in low application rate leads to their uniform distribution, quick and immediate response as well as solve of fertilization problems.

Although micronutrients are needed in relatively very small quantities for adequate plant growth and production, their deficiencies cause a great disturbance in the different physiological and metabolic processes inside the plant. Copper is considered an essential micronutrient for plant growth as a component of the phenolase, lactase and ascorbic acid oxidase enzymes (Brown and Clark, 1977). Moreover, most of Cu functions are based on the participation of enzymatically bound Cu in redox reactions. Copper also affects the formation and chemical composition of cell wall (Marschner, 1998). Furthermore, El-Aref and Hamada (1998) showed that Cu stress reduced some enzymatic bonds of alcohol dehydrogenase and esterase and the content of soluble carbohydrates during the vegetative growth.

Therefore, the objective of this study was to evaluate the positive impacts of either sulphur or copper application at different levels and their possible combinations on the growth parameters of onion bulb yield, its nutrients content and storability.

MATERIALS AND METHODS

A field experiment was conducted at Kafr El-Akram Village, Quessna region, Menufiya Governorate during the two successive winter seasons of 2007/ 2008 and 2008/ 2009. Some physical and chemical properties of the experimental soil were determined according to Black (1965) and Page *et al.,* (1982), and are presented in Table (1).

Seeds of onion (Allium cepa L., cv. Giza 20) were sown in the nursery on the 14th and 21th October for the first and second seasons, respectively. After 60 days, uniform transplants were planted at 10 cm apart on both sides of the ridges. The experimental plot area was 10.5 m^2, which included 5 rows, with 3.5 m in length and 60 cm in width for each one.

Twelve treatments were involved in this experiment, i.e., three rates of elemental finely ground sulphur (0, 0.5 and 1.0 ton/fed) were applied during soil preparation and four levels of copper as EDTA form at rates of (0, 100, 200 and 300 mg Cu/L) which were used in the liquid forms and sprayed twice (after 60 and 75 days from transplanting with a rate of 400 L/fed).

Table 1

The experimental design was split plot in randomized complete blocks, with three replicates. Elemetal sulphur was arranged as the main plots, whereas copper levels were randomly assigned in sub plots.

NPK fertilizers were applied at the rates of 90 kg N/fed as ammonium nitrate (33.5% N), 60 Kg P_2O_5/fed as supermonophosphate (15.5% P_2O_5) and 100 Kg K_2O/fed. as potassium sulphate (48.0% K_2O). Superphosphate was broadcasted during soil preparation. Nitragen and potassium fertilizers were added in two equal doses at 30 and 60 days after transplanting. The other usual agronomic processes of onion plants were practiced as recommended by the Ministry of Agriculture and Land Reclamation.

Data recorded:

After 100 days from transplanting, random samples of five onion plants were taken from the two outer rows of each sub plot to determine plant height (cm), number of tubular blades/plant, diameter of bulb or neck and dry weights of different organs of onion. Plant organs were dried at 70 °C for 72 hours, and were wet digested for determining N, P and K. Total N was determined using kjeldahl method according to Jackson (1973). Phosphorus was determined color- metrically as described by Jackson (1973). Potassium was determined by flame photometerically as described by Chapman and Pratt (1961).

At maturity (after 150 days from transplanting), the total bulb yield in each plot was weighted and recorded in ton/fed. In addition, random samples of 10 bulbs were chosen from every plot to determine the average weight of bulb in g, bulb diameter and the percentage of dry matter content. The total soluble solids (T.S.S.) in fresh blubs (Juice) were estimated using carlzeiss refractometer (A.O.A.C 1990). N, P and K in bulb were determined according to Page *et al.* (1982).

Storability evaluation:

A sample of 5 kg cured uniform bulbs was taken from each plot, packed in conventional mesh bags and stored at room temperature (20-30 °C, 60-70% RH) for 5 months. Monthly, bulbs were inspected, the rotted and sprouted bulbs were discarded and the remaining ones were weighted. Weight loss of bulbs were estimated as percentage of the original weight.

RESULTS AND DISCUSSION

1. Effect of sulphur treatments on soil chemical characters:

Data in Table (2) clearly showed that sulphur application apparently decreased the soil pH and increased the EC, organic matter and available nutrients (N, P and K) in the treated soil as compared with the untreated one. Soluble monovalent cations (Na^+ and K^+) and anions (HCO^-_3 and CL^-) were also decreased, while divalent cations (Ca^{++} and Mg^{++}) and anions ($SO^=_4$)

Table 2

were increased under the addition of different levels of sulphur. The sulphur effects on soil characters were more pronounced during the second season. Moreover, the addition of 1.0 ton S/fed was more effective for soil characters than the applied 0.5 ton S/fed. Similar results were obtained by Modaihsh and Metwally, (1989) and Nassar (2007). Application of sulphur to the soil led to its oxidation to $SO^{=}_4$ and sulphuric acid by specific soil microbs and hence reducing soil pH (Salem *et al.,* 2004 and El-Shouny, 2006).

2. Growth parameters of onion plants:

Results of onion characters of the studied growing seasons gave nearly the same trends. So, the obtained data was statistically analyzed using the combined analysis of the two growing seasons according to Gomez and Gomez (1984). L.S.D. test at 5% level of significance was used for comparing between the means of different treatments.

Data presented in Table (3), generally showed significant increments in all studied growth characters of onion plants due to sulphur application, e.g., plant height (cm), bulb diameter (cm), neck diameter (cm) and the dry weight of onion organs, which were corresponded to increase sulphur levels. Application of S at 1.0 ton/fed gave significantly higher mean values for all studied growth characters as compared with those of the control or 0.5 ton S/fed. The increases in plant growth parameters may be due to the favourable effect of sulphur on reducing soil pH, improving soil structure and increasing the availability of certain plant nutrients in the experimental soil (El-Galla *et al.,* 1989). Other possibility could be due either to the fact that sulphur is required with greater supplies for onion and garlic than other crops (Schultz *et al.,* 1966) or for the synthesis of coenzyme A and amino acid for protein elaboration and for formation of chlorophyll and certain disulphide linkages that have been associated with structural characteristics of plant protoplasm (Marschner, 1998). Similar results are in conformity with those obtained by Gawish (1997) and El-Shafie and El-Gamaily (2002).

Data in Table (3) also showed that increasing the spraying level of copper markedly increased all growth parameters of onion plants under study. The greatest values were observed for foliar spraying at a rate of 300 mg Cu/L. Simultaneously, as compared with the other treatments and control one, this increase may be due to the positive effect of Cu on the plant growth through its direct influence on enzymes activities and redox reactions, since the rate of photosynthesis can also be related to Cu role in chloroplast (Marschner, 1998). These results are in harmony with those obtained by El-Shafia and El-Gamaily (2002) and Nassar (2007).

From the obtained data of the interaction effect between sulphur and copper treatments as shown in Table (3), it can be concluded that the combination of 1.0 ton S/fed with 300 mg Cu/L. seemed to be the best treatment for all growth parameters studied.

Table (3): Some growth parameters of onion plants at 100 days from transplanting as affected by applied sulphur and copper.

Sulphur levels (ton/fed)	Copper levels (mg/L)	Plant height (cm)	Number of tubular blades/ plant	Diameter (cm)		Dry weight (g/plant)		
				Bulb	Neck	Tubular blades	Bulb	Whole plant
0	0	58.76	4.50	3.47	1.81	3.25	3.80	7.05
	100	62.52	4.86	3.65	2.13	3.64	4.11	7.75
	200	68.39	5.08	4.24	2.37	4.10	4.39	8.49
	300	70.58	5.46	4.55	2.41	4.39	4.83	9.22
Mean		65.06	4.97	3.98	2.18	3.85	4.28	8.13
0.5	0	63.13	5.03	3.93	1.88	3.98	4.16	8.14
	100	66.57	5.59	4.33	2.31	4.64	4.73	9.37
	200	71.06	5.87	4.69	2.37	5.03	5.87	10.90
	300	78.14	6.30	4.89	2.43	5.62	6.15	11.77
Mean		69.73	5.70	4.46	2.25	4.82	5.23	10.05
10	0	72.72	5.60	4.25	2.10	4.39	4.61	9.00
	100	76.85	6.13	4.55	2.39	4.97	5.38	10.35
	200	81.32	6.52	4.88	2.44	5.74	6.11	11.85
	300	88.35	6.87	5.34	2.50	6.57	6.38	12.95
Mean		79.81	6.28	4.76	2.35	5.42	5.62	11.04
Mean of copper levels	0	64.87	5.04	3.88	1.93	3.87	4.19	8.06
	100	68.65	5.53	4.18	2.27	4.42	4.74	9.16
	200	73.59	5.82	4.60	2.39	4.96	5.46	10.41
	300	79.02	6.21	4.93	2.45	5.53	5.79	11.31
L.S.D. of 5%								
S	-	1.5	0.08	0.14	0.02	0.08	0.09	0.14
Cu	-	0.65	0.09	0.41	0.03	0.03	0.05	0.07
S x Cu	-	1.12	NS	0.07	0.05	0.06	0.09	0.13

3. Yield and its Quality:

Data presented in Table (4) reveal that application of sulphur significantly augmented total yield of bulb, bulb diameter, average bulb weight, bulb dry matter and total soluble solids % (T.S.S. %). The influence of sulphur on the yield of onion could be explained either to the beneficial effect of sulphur on increasing availability of nutrients through lowering soil pH, and thereby enhances metabolic activities within plants, and then improves number of leaves, leaf area and encourage much more metabolites to store in bulbs or to the effect of sulphur on the bulb quantity, as a result of increasing the volatile sulphide content in the maturity and bulb size (Peterson, 1979). Likewise, it may be also due to the important role of sulphur in plant protein and some hormones formation, besides sulphur is necessary for enzymatic action, chlorophyll formation, synthesis of certain amino acids and vitamins, hence it helps to have a good vegetative growth leading to have a high yield (Tisdale and Nelson, 1985).

As regard to the effect of spraying onion with copper, the same data in Table (4) indicated that increasing the spraying level of copper led to increase onion yield and its quality. For all parameters, the greatest values were observed for foliar spraying at 300 mg Cu/L, simultaneously, compared with the other treatments and control one. The simulative effect of Cu spraying could be explained on the basis that Cu is considered a component of various enzymes. Cu functions are mainly related to its enzymatic bond in redox reactions (Mengel and Kirkby, 1987). The rate of photosynthesis can also be related to the role of Cu in chloroplast. Furthermore, Cu has a marked effect on the formation and chemical composition of cell wall (Marschner, 1998). Similar results were attained by Allam (1999), El-Shafie and El-Gamaily (2002) and Ewais *et al.* (2006).

As for combined effect, it is clear from Table (4) that the combination of 1.0 ton S/fed with 300 mg Cu/L, seemed to be the best treatment for onion yield and its quality.

Table (4): Effect of applied sulphur and Copper foliar spraying on onion bulbs yield and its quality parameters.

Sulphur levels (ton/fed)	Copper levels (mg/L)	Total yield of bulb (ton/fed)	Bulb diamerer (cm)	Average bulb weight (g)	Bulb dry matter (%)	Total soluble solids (%)
0	0	14.68	4.63	87.66	9.58	12.37
	100	15.31	5.31	95.24	10.60	12.53
	200	16.50	5.52	101.58	10.89	12.75
	300	17.13	5.78	106.89	11.47	12.83
	Mean	15.91	5.31	97.84	10.63	12.62
0.5	0	16.28	5.98	112.41	12.19	13.21
	100	18.17	6.32	118.25	13.65	13.41
	200	19.62	6.61	122.56	13.98	13.72
	300	20.13	6.97	125.87	14.38	13.91
	Mean	18.55	6.47	119.77	13.55	13.56
1.0	0	18.12	7.33	131.96	14.35	14.24
	100	19.59	7.96	138.79	15.11	14.53
	200	20.34	8.33	146.02	15.76	14.69
	300	22.01	8.59	151.70	16.53	14.80
	Mean	20.02	8.05	142.12	15.43	14.57
Mean of copper levels	0	16.36	5.98	110.68	12.04	13.27
	100	17.69	6.53	117.43	13.12	13.49
	200	18.82	6.82	123.39	13.54	13.72
	300	19.76	7.11	128.15	14.13	13.84
L.S.D. of 5%						
S	-	0.81	0.15	0.14	2.86	0.06
Cu	-	0.43	0.13	0.04	0.98	0.07
S x Cu	-	0.40	0.23	0.07	1.69	0.12

4. Nitrogen, phosphorus and potassium contents of onion bulbs:

The available forms of N, P and K in the soil is an important factor for the absorbtion of these nutrients by onion plants as well as their contents. Therefore, N, P and K contents were determined in the tubular blades and bulbs of onion during the growth and the harvest stages, as follows.

4.1. Growth stage (100 days from transplanting):

Data presented in Table (5) cleary showed that, the concentration and uptake of N, P and K in both tubular blades and bulbs at 100 days from transplanting were significantly increased by adding sulphur and copper rates. It is noticed obvious that the uptake of both N and K was relatively high in the tubular blades as compared to that in the bulb of onion plants, while the opposite trend was observed for the P uptake. Similar results are obtained by El-Shafie and El-Gamialy (2002) and Mahmoud (2006). Also, these results are in accordance with those reported by El-Galla *et al.* (1989) who found that applying sulphur increased K content in plants. The positive effect of applied sulphur may be due to either increasing the solubility and availability of P in soil as a results of reducing soil pH or release of phosphate anions from soil colloids by sulphate anions.

Data in Table (5) also showed that foliar spraying with copper led to increase N, P and K concentration and uptake in both tubular blades and bulbs of onion plants. The favourable impact of Cu on macronutrients contents of onion plants may be due to its effect on the form of vegetative plant material, which in turn increase the uptake of N, P and K by plants. Similar results were attained by Ewais *et al.,* (2006).

Combined effect, as shown in Table (5), leads to a conclution that the combination of 1.0 ton S/fed. with 300 mg Cu/L seemed to be the best treatment for N, P and K uptake in both tubular blades and bulbs of onion plants.

4.2. Harvest stage (150 days from transplanting):

Data recorded in Table (6) showed that the N, P and K concentration and uptake by of onion bulbs at harvest stage were significantly increased with application of sulphur and copper. The greatest values were obtained by applying the highest rates of both sulphur and copper. The positive effect of sulphur application may be due to the important role of S in plant protein and some hormones formation, also S is necessary for enzymatic action, chlorophyll formation, synthesis of certain amino acids and vitamins, hence, it helps to have a good growth, and leading to have a high yield (Marschner, 1998). The positive effect of copper may be due to a physiological relationship of nutrients intake of complemetary ion by plants root.

Table 5

Table (6): Effect of applying sulphur and copper foliar spraying on N, P and K contents of onion bulbs at harvest.

Sulphur levels (ton/fed)	Copper levels (mg/L)	Nitrogen		Phosphorus		Potassium	
		%	Uptake (kg/fed)	%	Uptake (kg/fed)	%	Uptake (kg/fed)
0	0	0.42	61.65	0.20	29.36	0.88	129.18
	100	0.72	110.26	0.23	35.22	1.13	173.04
	200	0.80	132.03	0.26	42.91	1.35	222.79
	300	0.89	152.46	0.31	53.10	1.43	244.96
	Mean	0.71	114.10	0.25	40.15	1.19	192.49
0.5	0	0.62	100.94	0.21	34.19	1.06	172.57
	100	0.82	149.02	0.24	43.62	1.19	216.26
	200	0.93	182.43	0.30	58.85	1.41	276.60
	300	0.98	197.24	0.33	66.42	1.56	313.98
	Mean	0.84	157.41	0.26	50.77	1.30	244.85
1.0	0	0.83	150.39	0.30	54.36	1.13	204.76
	100	0.93	182.22	0.35	68.58	1.37	268.43
	200	1.00	203.37	0.39	79.31	1.52	309.11
	300	1.11	244.46	0.42	92.50	1.68	369.99
	Mean	0.97	195.11	0.36	73.68	1.42	288.07
Mean of copper levels	0	0.62	104.33	0.23	39.30	1.02	168.84
	100	0.82	147.17	0.27	49.14	1.23	219.24
	200	0.91	172.61	0.32	60.36	1.42	269.50
	300	0.99	198.05	0.35	70.67	1.55	309.64
L.S.D. of 5%							
S		-	0.04	-	1.04	-	0.38
Cu		-	0.05	-	1.13	-	0.39
S x Cu		-	NS	-	1.96	-	0.40

5. Storability :

The effect of different levels of sulphur and copper as well as their combinations on the total weight loss percentage of onion bulbs are demonstrated in Table (7). It is obvious that sulphur significantly reduced weight loss of bulbs stored at room temperature conditions. This decrease in

weight loss may be interpreted on the basis that bulbs produced from plants received the sulphur rate (1.0 ton S/fed) produced a higher dry matter yield (Table, 4). In this connection, Gawish (1997), stated that the sulphur application of onion plants improved the storability of bulbs.

Table (7): Effect of applying sulphur and copper foliar spraying on the total weight loss percentage of onion bulbs during different periods.

Sulphur levels (ton/fed)	Copper levels (mg/L)	Weight loss % Storage period (days)				
		30	60	90	120	150
0	0	3.51	5.46	7.96	12.41	15.50
	100	3.39	5.33	7.64	12.29	15.37
	200	3.32	5.27	7.53	12.22	15.28
	300	3.29	5.16	7.40	12.11	15.16
	Mean	3.38	5.31	7.63	12.26	15.24
0.5	0	3.30	5.15	7.68	12.06	14.91
	100	3.25	5.09	7.50	11.88	14.72
	200	3.25	5.04	7.36	11.73	14.52
	300	3.18	4.97	7.22	11.60	14.36
	Mean	3.24	5.06	7.44	11.57	14.63
1.0	0	3.21	4.88	7.58	11.73	14.34
	100	3.15	4.73	7.46	11.60	14.20
	200	3.10	4.65	7.33	11.40	14.11
	300	3.05	4.56	7.28	11.29	14.03
	Mean	3.13	4.70	7.41	11.51	14.17
Mean of copper levels	0	3.34	5.16	7.74	12.07	14.92
	100	3.26	5.05	7.53	11.92	14.76
	200	3.22	4.99	7.40	11.78	14.64
	300	3.17	4.90	7.30	11.67	14.52
L.S.D. of 5%						
S	-	1.76	0.02	NS	0.03	0.22
Cu	-	1.76	0.37	0.06	0.05	0.18
S x Cu	-	3.05	NS	NS	NS	NS

Also, spraying the onion plants with copper at a rate of 300 mg Cu/L significantly decreased the weight loss of onion bulbs (Table, 7). This may be due to Cu plays a role in the synthesis and activity of phenols, lignin, polyphenol oxidase and peroxidase, which lead to disease resistance, Ewaise *et al.* (2006).

Data in Table (7) indicated, also that the interaction effect between sulphur and copper caused non-significant impacts on the total weight loss percentage of onion bulbs during all storage periods, except after 30 days.

Therefore, it could be concluded that application of 1.0 ton S/fed with 300 mg Cu/L as foliar application gave the greatest values of bulb yield and improved its quality and nutritive content as well as the storability value of the resultant bulbs.

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis of the Association Official Analysis Chemist. 15th Ed. Washington, D.C., U.S.A.

Alexander, A. (1986). Foliar fertilization. Schering Agrochemical Devision, Special Fertilizer Group, Berlin: 17-60.

Allam, A.M.M. (1999). Physiological studies of the productivity and storageability of some onion cultivars. PH.D. Thesis, Faculty of Agric., Cairo Univ., Egypt.

Black, C.A. (1965). "Methods of Soil Analysis". Parts I and II. Amer. Soc. of Agron. Inc. Publ. Madison, Wisconsin, U.S.A.

Brown, J.C. and R.B. Clark (1977). Copper as essential to wheat reproduction. Plant and Soil, 48: 509-523.

Chapman, D.H. and P.F. Pratt (1961). Methods of Analysis for Soils. Plant and Water. Califorina Univ., Division of Agric. Science.

El-Aref, H.M. and A.M. Hamada (1998). Genotype differences and alterations of protein patterns of tomato plants under copper stress. Biolog. Plantarum, 41 (4): 555-564.

El-Galla, A.M., M.A. Mostafa and S.E. El-Maghraby (1989). Influence of sulphur and saline irrigation water on growth and elemental status of barley plant on growth in calcareous soils. Egypt. J. Soil. Sci. Special. Issue, 31: 443-455.

El-Shafie, Fatma S. and Eida E. El-Gamaily (2002). Effect of organic manure, sulphur and microelements on growth, bulb yield, storability and chemical composition of onion plant. Minufiya J. Agric. Res., 27 (2): 407-424.

El-Shouny, M.M. (2006). The effect of some soil amendments on soil properties and wheat production in salt affected soils. Minufiya J. Agric. Res., 31 (4): 1105-1117.

Ewais, Magda A., K.E.M. Nassar, A. Mahmoud Awatef and S.F. Monsour (2006). Effect of phosphorus and copper foliar spraying on the yield, mineral content and quality of onion plants. J. Adv. Agric. Res. (Fac. Agric. of Saba Basha), 11 (2): 399-408.

Fathi, A.I., B.A. Ismail, S.A.I. Eisa and M.O. Easa (2003). Effect of nitrogen, sulphur and boron fertilization on growth yield and quality of canola. Egypt. J. Appl. Sci., 18 (8): 317-330.

Gawish, Ragaa, A. (1997). Current studies on onion and its pungency: I. Growth, yield storability of onion as affected by sulphur fertilization. Zagazig J. Agric. Res., 24 (3): 491-510.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons, Inc. New York.

Jackson, M.L. (1973). Soil Chemical Analysis. 2nd Ed. Prentice-Hall of India Private and L.T.D., New Delhi, India.

Mahmoud, M.R. (2006). Effect of some organic and inorganic nitrogen fertilizers on onion plants grown on a sandy calcareous soil. Assiut Journal of Agric. Sci., 37 (1): 147-159.

Marschner, H. (1998): Mineral Nutration in Higher Plants. Harcount Brace & Company, Publishers, London, New York, Tokyo.

Mengel, K. and E.A. Kirkby (1987). Principles of Plant Nutrition. International Potash Institute Bern, Switzerland.

Modaihsh, W.A. and A.L. Metwally (1989). Effect of elemental sulphur on chemical changes and nutrient availability in calcareous soils. Plant and Soil, 116: 95-101.

Mohammed, F.I. and Sh.H. Kandeel (1998). Effect of soil sulphur application on plant growth, yield components and chemical constituents of pea cultivars. Egypt J. Appl. Sci., 13 (4): 195-209.

Nassar, K.E.M. (2007). Response of faba bean and soybean to direct and residual impacts of elemental sulphur at different levels of phosphorus and iron spraying under calcareous soil condition. Minufiya J. Agric. Res., 32 (2): 537-552.

Nassar, K.E.M., Magda A. Ewais and Awatef A. Mahmoud (2006). Raising of the quantity and quality of onion crop by foliar application of phosphorus and sulphur. J. Adv. Agric. Res., Fac. Agric. of Saba Basha., 11 (2): 409-419.

Page, A.L., R.H. Miller and D.R. Keeny, Eds. (1982). Methods of Soil Analysis. Part 2: Chemical and Microbiological properties. Amer. Soc. Agron. Madison, Wisconsin. U.S.A.

Paul, A.A. and D.A. Southgate (1987). In the Composition of Foods 4th Ed., McCone and Widdowson, London.

Peterson, D.R. (1979). Sulphur fertilizer effects on onion yield and pungency. Tex. Agric. Expt. Sta. Prog. Red., pp. 355 I.

Rajes, R.N., S.N. Ghulax and S.R. Tayde (1993). Effect of varying levels of sulphur and spacing compared with frequencies of irrigation on yield of onion grown in vidarbha J. Soil and Crops, 3 (1): 37-40.

Salem, F.S., M.Y. Gebrail, M.O. Easa and M. Abd El-Warth (2004). Raising the efficiency of nitrogen fertilization for wheat plants under salt affected soils

by applying some soil amendments. Minufiya J. Agric. Res., 29 (4): 1059-1073.

Schultz, J.W., E.A. Day and L.M. Libbey (1966). Respose of vegetables to sulphur fertilization. Symposium on Sulphur in Agriculture. Soil. Sci., 101: 229-345.

Tisdale, S.L. and W.L. Nelson (1985). Soil fertility and Fertilizers. 3nd Ed. Macmillan Publishing Co. Inc., New York and Collico Macmillan Publishers, London.

إستجابة نباتات البصل النامية فى أرض طينية لإضافة الكبريت المعدنى والرش بالنحاس

مطاوع مطاوع الشوني ، سامى عبدالحكيم الشيخة ، سمير فتوح الفقى
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

الملخص العربي

أجريت تجربة حقلية فى قرية كفر الأكرم . مركز قويسنا . محافظة المنوفية خلال الموسمين الشتويين المتتاليين لعامى ٢٠٠٧/ ٢٠٠٨ ، ٢٠٠٨/ ٢٠٠٩ لدراسة تأثير الإضافة الأرضية للكبريت المعدنى بمعدلات (صفر ، ½ ، ١ طن كبريت لكل فدان) والرش بالنحاس عند مستويات (صفر ، ١٠٠ ، ٢٠٠ ، ٣٠٠ ملليجرام نحاس لكل لتر) فى صورة مخلبية وكذلك التفاعل بينهما على صفات النمو الخضرى (طول النبات ، قطر العنق والبصلة ، الوزن الجاف للبصلة بعد ١٠٠ يوم من الشتل) وكذلك محصول البصل (صنف جيزة ٢٠) وجودته ومحتواه من المغذيات وكذلك الفترة التخزينية للبصل .

وقد أوضحت النتائج المتحصل عليها أن :

- أدت إضافة المستويات المختلفة من الكبريت الى خفض قيم pH التربة ، وكذلك محتوى التربة من الكاتيونات والأنيونات الأحادية الذائبة (الصوديوم ، البوتاسيوم ، الكلوريد ، البيكربونات) ، والعكس تماما بالنسبة لقيم المادة العضوية والتوصيل الكهربى (EC) ومحتوى التربة من الكاتيونات والأنيونات الثنائية الذائبة (الكالسيوم ، الماغسيوم ، الكبريتات) وكانت أفضل النتائج المتحصل عليها عند إضافة ١ طن كبريت لكل فدان مقارنة بباقى المعاملات .
- أدت الإضافة الأرضية للكبريت مع الرش الورقى بالنحاس عند جميع مستويات الاضافة الى زيادة معنوية فى كل من قياسات النمو الخضرى بعد ١٠٠ يوم من الشتل وكذلك محصول البصل وجودته والقدرة التخزينية .

- زاد المحتوى الميسر من مغذيات النتروجين والفوسفور والبوتاسيوم فى التربة وكذلك الممتص فى أجزاء نباتات البصل المختلفة زيادة معنوية مع زيادة مستويات الاضافة لكل من الكبريت والنحاس .
- أوضحت نتائج الدراسة التأثير الايجابى لإضافة الكبريت والنحاس على جميع القياسات تحت الدراسة .
- من النتائج السابقة يمكن التوصية بإضافة ١ طن كبريت لكل فدان مع الرش مرتين (بعد ٦٠ ، ٧٥ يوم من الشتل) بعنصر النحاس بتركيز ٣٠٠ ملليجرام نحاس لكل لتر بمعدل ٤٠٠ لتر/فدان لزيادة محصول البصل وتحسين قياسات الجودة ومحتوى البصل من العناصر الغذائية وكذلك زيادة قدرته التخزينية ، كما أن الإضافة الأرضية للكبريت تعمل على تحسين خواص التربة الطبيعية والكيميائية مما ينعكس ذلك ايجابيا على زيادة انتاجية التربة .

Table (1): Some physical and chemical properties of the experimental soil during the two investigated seasons:

a) $CaCO_3$, organic matter and particle size distribution.

Season	Total $CaCO_3$ %	Organic matter %	Partical size distribution %				
			Coarse sand	Fine sand	Silt	Clay	Texture class
2007/2008	2.33	1.65	2.06	15.40	32.95	49.59	Clayey
2008/2009	2.28	1.88	1.86	14.68	34.84	48.62	Clayey

b) Chemical analysis of soil paste extract and available NPK

Season	pH (1: 2.5 soil susp.)	EC (dSm^{-1})	Soluble ions (m mole L^{-1})								Available nutrients (mg/kg^{-1})		
			Cations				Anions						
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$	N	P	K
2007/2008	7.80	2.40	7.60	4.30	11.40	0.70	--	3.10	12.90	8.00	42	5	286
2008/2009	7.70	2.33	7.72	4.21	10.80	0.59	--	3.00	11.00	9.32	48	7	305

Table (2): Effect of sulphur application on some chemical properties of the used experimental soil.

Sulphur levels (ton/fed)	Organic matter %	pH (1: 2.5 soil susp.)	EC (dSm^{-1})	Soluble cations(m mole L^{-1})				Soluble anions (m mole L^{-1})				Available nutrients (mg/kg^{-1})		
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_{3}$	HCO^{-}_{3}	Cl^{-}	$SO^{=}_{4}$	N	P	K
2007/2008														
0.0	1.73	7.80	2.33	7.65	4.21	10.80	0.66	--	3.00	11.00	9.32	42	9.0	205
0.5	1.88	7.70	2.50	9.53	5.25	9.60	0.62	--	3.00	10.30	11.70	48	10.0	235
1.0	2.05	7.60	2.64	11.66	5.91	8.25	0.58	--	2.86	9.70	13.84	53	11.5	293
2008/2009														
0.0	1.63	7.70	2.42	6.96	4.94	11.89	0.41	--	3.25	12.33	8.62	36	10	250
0.5	2.10	7.50	2.67	10.83	6.47	8.87	0.56	--	2.81	9.93	13.96	49	12	273
1.0	2.32	7.40	2.91	15.45	8.21	6.93	0.45	--	2.76	7.04	19.30	62	12.5	319

Table (5): Concentration (%) and uptake (mg/plant) of N, P and K of onion plants at 100 days from transplanting as affected by sulphur and copper.

Sulphur levels (ton/fed)	Copper levels (mg/L)	Tubular blades						Bulbs					
		N		P		K		N		P		K	
		%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant	%	mg/plant
0		1.73	56.22	0.18	5.58	1.63	52.97	1.20	45.60	0.20	7.60	0.86	32.68
	100	2.02	73.53	0.21	7.64	1.68	61.15	1.25	51.11	0.23	9.45	1.43	58.77
	200	2.13	87.33	0.23	9.43	1.75	71.75	1.35	59.26	0.27	11.85	1.60	70.24
	300	2.21	97.02	0.27	11.85	1.80	79.02	1.38	66.65	0.33	15.94	1.71	82.59
	Mean	2.02	78.52	0.22	8.62	1.71	66.22	1.29	55.65	0.26	11.21	1.40	61.07
0.5	0	1.80	71.64	0.23	9.15	1.81	72.04	1.41	58.66	0.31	12.90	1.25	52.00
	100	2.18	101.15	0.25	11.60	1.93	89.55	1.85	87.50	0.33	15.61	1.43	67.64
	200	2.27	114.18	0.29	14.58	2.13	107.14	1.92	112.70	0.36	21.13	1.52	89.22
	300	2.32	130.38	0.31	17.42	2.29	128.69	2.05	126.07	0.40	24.60	1.61	99.01
	Mean	2.14	104.33	0.27	13.18	2.04	99.35	1.80	96.23	0.35	18.56	1.45	76.96
1.0	0	2.01	88.24	0.25	10.97	2.43	106.67	1.63	70.14	0.33	15.21	1.33	61.31
	100	2.32	115.30	0.29	14.41	2.53	125.74	1.90	102.22	0.37	19.90	1.49	80.16
	200	2.46	141.20	0.33	18.94	2.79	160.14	1.96	119.76	0.42	25.66	1.56	95.31
	300	2.73	179.36	0.36	23.65	2.91	191.19	2.15	137.17	0.51	32.54	1.70	108.46
	Mean	2.38	131.02	0.31	16.99	2.66	145.93	1.91	107.32	0.41	23.32	1.52	86.31
Mean of copper levels	0	1.84	72.03	0.22	8.56	1.95	77.22	1.41	58.13	0.28	11.90	1.14	48.66
	100	2.17	96.66	0.25	11.21	2.04	92.14	1.66	80.27	0.31	14.98	1.45	68.85
	200	2.28	114.23	0.28	14.31	2.15	113.01	1.74	97.24	0.35	19.54	1.56	84.92
	300	2.42	135.58	0.31	17.64	2.33	132.96	1.86	109.96	0.41	24.36	1.67	96.68
L.S.D. of 5%													
S		-	1.73	-	0.20	-	14.02	-	1.65	-	0.45	-	1.40
Cu		-	0.75	-	0.09	-	11.38	-	0.80	-	0.57	-	0.82
S x Cu		-	1.29	-	0.20	-	0.62	-	1.39	-	0.99	-	1.42