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EFFECT OF FOLIAR SPRAY WITH SOME MICRONUTRIENTS AND SLOW RELEASE NITROGEN FERTILIZERS RATES ON PRODUCTIVITY AND QUALITY OF SWEET POTATO (*Ipomea batats* L.).

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ABSTRACT

The present investigation was carried out at El- Bramoon Experimental Farm, Hort. Res. Institute, Mansoura, Dakahlia Governorate, Egypt (+ 7m altitude, 30^{o} 11^{-} latitude and 28^{o} 26^{-} longitude), during seasons of 2012 and 2013, to study the effect of slow release-N Sulfur coated urea "SCU" rats, and foliar spray with some micronutrients levels as well as their interaction on productivity, and quality of sweet potato cv. Abees. The most important finding could be summarized as follows:

In general, results showed that the plants sprayed with mixture of micronutrients were better than those of the unsprayed ones. Increasing the foliar applied mixture of micronutrients concentration from 0 to 50 ppm significantly increase plant height, plant dry weight and leaves area/plant as well as total yield, marketable yield and weight, length and diameter. Moreover, foliar application of mixture of micronutrients significantly increased concentrations of N in the first season only. In addition, reducing sugar and carotene were increased in both seasons. Foliar spray with mixture of micronutrients at 50 ppm had the most interesting observation in the enhancing of most studied characters.

On the other hand, application of slow release nitrogen fertilizers rates gave rise to significant increases in plant height, number of branches/plant; plant dry weight, leaves area/plant ratio, total yield, marketable yield and weight, length and diameter as well as chemical and organic constituents on tuber root of sweet potato. The application of 60 kgN/fed. sulfur coated urea "SCU", was superior on all studied characters.

The combined treatments of sprayed with mixture of micronutrients and sulfur coated urea "SCU" were generally more effective on the most studied parameters than single ones. The best results were obtained by foliar sprayed with micronutrients at 50 ppm and application with 60 kg N/fed. sulfur coated urea "SCU" gave the highest values of plant growth, yield and its components as well as chemical and organic constituents in both seasons compared with the other treatments. Therefore, this treatment could be recommended for raising sweet potato productivity and quality under similar conditions to this work.

Keywords: sweet potato, slow release N-fertilizers, sulfur coated urea, micronutrients.

INTRODUCTION

Sweet potato (*Ipomoea batatas*, L) is an important and leading vegetable crop of tropical and subtropical countries. It is considered a native of tropical America. Sweet potato is a swollen, fleshy rooted perennial with prostrate or slender stems. It is extremely heterozygous and is a hexaploid with a somatic chromosome number of 90. It is considered the only specie (out of 400 species) that belongs to Convolvulacea family and has economical importance.

Recently, sweet potato received a great attention become of its suitability for exportation. Great efforts have been directed to improve sweet potato production and quality for the purpose of increasing exported yield. Application of adequate amounts of nitrogen fertilizer and micronutrients are among factors involved in improving plant growth, tuber roots yield and quality of sweet potato

The nutrition of plants by foliar application is not only an addition channel of nutrients but also a mean of regulating root absorption by such plants (El-Hawary, 1999). The important of spraying micronutrients, i.e., Fe, Zn an Mn can be accounted by it's essential role in respiration, N metabolism activation of the enzyme, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis (Nijjar 1985 and Marschner, 1995).

Nile valley soils faced numerous deteriorating problems during the last decades, among which is shifting the PH value to the alkaline side, rending most plant nutrient in unavailable forms. These deterioration problems are reflected on plant productivity at a time of increasing demands on food to satisfy the needs of an ever growing population in Egypt. To achieve high yields, most farmers are applying intensive and non-rational rates of mineral fertilizer. Most of the elements of these fertilizers are either fixed in the soil or leached to pollute the environment and cause an increase in production costs (El- Haddad *et al*., 1993; Saif El-deen, 2000; Gouda, 2008 and El-Morsy and Shokr, 2005).

Nitrogen is the most limiting nutrient for crop production in many of the world's agricultural areas and its efficient use is important for the economic sustainability of cropping systems. Furthermore, the dynamic nature of N and its tendency for losing from soil-plant systems creates a unique and challenging environment for its efficient management. Crop response to applied N and use efficiency are important criteria for evaluating crop N requirements for maximum economic yield. Recovery of N in crop plants is usually less than 50% worldwide. Low recovery of N in annual crop is associated with its loss by volatilization, leaching, surface runoff, denitrification, and plant canopy. Low recovery of N is not only responsible for higher cost of crop production, but also for environmental pollution. Hence, improving N use efficiency (NUE) is desirable to improve crop yields, reducing cost of production, and maintaining environmental quality (Shaviv, 2001; Fageria and Baligar, 2005; Chien *et al.,* 2009; Nyiraneza and Snapp, 2007; and Ezzat and Abd El-Hameed, 2010).

Fortunately under such conditions, it has become essential to use the untraditional fertilizers as a partial substitute or supplement for chemical fertilizers, reduce the costs of produced yield and environmental pollution as well as increase production and improve quality of vegetable crops. One of the ways is to use slow release nitrogenous fertilizers (SRNF) it is one of the most important alternatives to rationalize the use of soluble nitrogenous fertilizers and to protect the environment from nitrogen residue pollution, where nitrogen element is releasing at a slow rate throughout one season or more and the plants are able to take up most of it without waste. SRNF also promotes steady and uniform growth and guarantees high N-efficient use and reduces N- losses either by volatilization or leaching (Allen1984; Chatzoudis and Valkanas, 1995; Abbady *et al*., 1997; El-Mallah *et al*., 1998).

The main object of this work was to study the effects of foliar spray with some micronutrients rates, slow release-N levels as sulfur coated urea "SCU", and their interactions, on plant growth, yield and its components, as well as chemical constituents of tuber roots of sweet potato (*Ipomoea batatas*, L.) cv. Abees.

MATERIALS AND METHODS

Two field experiments were carried out at El-Bramoon Agricultural Research farm of Mansoura Horticultural Research station, during the two successive summer seasons of 2012 and 2013. The experiments were designed to investigate the effects of foliar spray with some micronutrients rates, slow release-N levels as sulfur coated urea "SCU", and their interactions, on plant growth, yield and its components, as well as chemical constituents of tuber roots of sweet potato (*Ipomoea batatas*, L.) cv. Abees.

Experimental Soil Analysis:

Randomized samples were collected from the experimental soil at 0.0 to 50.0 cm depth, before plantation to determine the physical and chemical properties in accordance to the methods of Black (1965), respectively. Data of soil analysis are presented in Table (1).

Table (1): Some physical and chemical properties of experimental soil.

Soil properties	Value	Soil properties	value
Physical		**Soluble anions (meq/L)**	
Coarse sand	7.71	CL^-	3.56
Fine sand	18.14	HCO_3^-	3.20
Silt	33.65	$CO_3^=$	0.00
Clay	40.50	$SO_4^=$	5.16
Texture	Clay-loam	**Soluble cations (meq/L)**	
Chemical		Ca^{++}	4.03
Organic matter (%)	1.95	Mg^{++}	1.35
$CaCO_3$	4.55	Na^+	1.21
E.C. (dSm^{-1} at 25^o)	1.12	K^+	5.33
PH (1:2.5 w/v)	8.11	**Available micronutrients (ppm)**	
Total – N (%)	0.20	Fe	3.62
Available-P (ppm)	11.72	Mn	1.51
		Zn	1.35
		Cu	0.52

Experimental design and tested treatments:

The experiments were designed as split plot system in a randomized complete blocks with 4 replicates for each treatment. The rates of micronutrients mixture (Fe, Zn and Mn) occupied the main plots, which subsequently subdivided into 4 subplots, each contained one level of slow release-N as sulfur coated urea "SCU",

Each subplot area was 17.5 m^2 and contained 5 rows; each was 5m in length and 0.7m in width. The experiment included 12 treatments which were the possible combinations of 3 micronutrient rates (control , 50 ppm and 100 ppm of Fe, Zn and Mn mixture) and 4 of the levels of slow release-N as sulfur coated urea "SCU", (0, 20, 40 and 60 kg N/fed.).

Time and method of treatments:

Micronutrients: A mixture of chelated micronutrients, i.e., Zn-EDTA (13%), Mn-EDTA (13%) and Fe-EDTA (13%), was applied to plants as foliar spray at 30, 45 and 60 days after transplanting. The mixture of micronutrients was applied at 0, 50 or 100 ppm.

Nitrogen slow release : as sulfur coated urea "SCU 37.8 % N" was used as a source of nitrogen, which was used at 4 different levels, e.g. 0, 20, 40 and 60 kg N/fed., at planting.

Cultural practices:

Sweet potato stem cuttings, about 20 cm length, were transplanted on the third top of slope ridges, at 25 cm apart, in the second week of April of both seasons of the study. Growing plants were fertilized with 300 kg/fed super phosphate, (15.5% P_2O_5) and 200 kg/fed. Potassium sulphate (48% K_2O). The added amount were equally divided and applied before planting and 45 days after transplanting. Other inter-cultural practices including weed and pest control were followed as instructed by the Ministry of Agriculture. Harvesting of tuber roots was done 140 days after transplanting, in both seasons.

Recorded Data:

1- Vegetative growth parameters:

Five representative plants were randomly picked up from subplot, 100 days after transplanting to measure the following parameters:-

a- Plant Length: It was measured in (cm), starting from the ground level to the tip of the longest branch.

b- Number of branches/plant: All branches of chosen plants were counted.

c- Leaf area/plant: it was calculated according to the formula described by Koller (1972) as follow: -

$$\text{Leaf area} = \frac{\text{Dry weight of leaves}}{\text{Dry weight of disks}} \times \text{No. of disks} \times \text{disk area}$$

d- Dry weight per plants

2- Yield and its components:

At harvest, 140 days from transplanting, all tuber roots of plants of each subplots were digged up, classified into two categories (marketable and non-marketable roots), then weighted to determine the total yield per feddan (tones). Marketable roots have a diameter of 3.0 to 6.5 cm, while non-marketable roots have a diameter of less than 3.0 cm or more than 6.5 cm according to the method described by Grang (1963).

3- Tuber root characters:

Tuber root samples (each of 10 storage roots) were randomly chosen at harvesting time from each treatment, to determine tuber root features as follows:

a- Average tuber root weight.

b- Average tuber root length.

c- Average tuber root diameter.

4- Chemical constituents:

a- Element concentrations:-

Tuber roots (after curing) were taken, water washed and oven dried at 70 C^{o} till constant weight. Dried samples were pulverized separately and samples of 0.2 gm each was acid digested with a mixture of sulfuric acid and hydrogen peroxide, to determine the following:-

1- Total Nitrogen (%) was measured as described by A.O.A.C. (1990).

2- Phosphorus (%) was determined colorimetericaly using the method described by Jhon (1970).

3- Potassium (%) was determined using a flame photometer as reported by Brown and Lilleland (1946).

4- Fe, Zn and Mn were measured using atomic absorption spectrophotometer (Chapman and Partt,1961).

b- Organic compositions:

Organic compositions were determined in roots after curing as follows:

1-Total carbohydrate contents according to the method of Michel *et al.,* 1956.

2- Reducing and non-reducing sugar (%) were determined according to the method of Dubois *et al. (*1956).

3-Carotene was determined according to the method described by Booth (1958).

Statistical analysis:

All recorded data were subjected to statistical Analysis of Variance and least significance differences (L.S.D) was used to separate means, as mentioned by Sndecor and Cochran (1980).

RESULTS AND DISCUSSION

1-Vegetative growth:

Data presented in Table (2) show the effect of foliar spray with mixture of micronutrients and slow release nitrogen fertilizers rates and their interactions on growth of sweet potato plants.

Concerning the effect of foliar spray with mixture of micronutrients, it is clear from such data in Table (2) that, dry weight of plant and leaves area plant significantly affected in both seasons of study. While, plant height significantly affected in the first season only. Meanwhile, Number of branches/plant was not significantly affected in both seasons, the highest vegetative growth characters were recorded by foliar sprayed with mixture of micronutrients at 50 ppm. Meanwhile, the lowest vegetative growth characters were recorded by control treatment (foliar spraying with tap water). the positive effect of micronutrients on plant vegetative growth parameters might be due to their essential roles in many important metabolic functions such as transport of carbohydrates, regulation of meristematic activity, photosynthesis, respiration, energy production and protein metabolism. Such functions would directly or indirectly contribute to plant growth (Srivastva and Gupta, 1996). The obtained results are in harmony with those of Saif ELDeen (2005), Abd El-Baky *et al.*(2010) on sweet potato, El-Moursi and Rezk (1987), Omran *et al.* (1991), Radwan and Tawfik (2004) on potato and El-Morsy (2005) and Abou El-Khair *et al.* (2011) on garlic, they found that spraying plants with mixture of micronutrients increased vine growth of plants as compared with the untreated ones.

Table (2): Vegetative growth characters of sweet potato plant as affected by foliar spry with mixture of micronutrients and slow release nitrogen fertilizers rates and their interactions during 2012 (S1) and 2013 (S2) seasons.

Characters / Treatments		Plant height (cm)		Number of branchs/plant		Shoot dry weight/plant (gm)		Leaves area (m^2)	
		S1	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Micronutrients- rates									
Control		127.8	127.1	14.8	15.4	109.26	119.65	0.822	0.714
50 ppm		133.7	146.6	16.6	17.0	129.83	131.36	1.028	0.967
100 ppm		136.1	141.7	16.7	16.3	119.53	121.74	0.953	0.921
LSD at 5%		2.0	N.S	N.S	N.S	10.89	4.6	0.085	0.109
Sulfur coated urea "SCU"									
Control		122.8	127.8	13.5	13.8	104.24	107.05	0.764	0.661
20 kg N/fed.		129.8	128.6	16.3	15.9	115.87	120.66	0.863	0.801
40 kg N/fed.		136.5	146.8	16.7	16.4	128.93	132.73	0.998	0.841
60 kg N/fed.		141.1	150.7	17.7	18.7	129.11	136.55	1.112	1.165
LSD at 5%		2.9	18.0	1.3	1.3	10.65	9.22	0.103	0.089
Interactions:									
Micro	SCU kgN/fed.								
Control	Control	118.8	121.9	13.2	12.9	97.52	100.93	0.620	0.556
	20	125.7	97.1	14.3	14.4	108.43	117.86	0.701	0.627
	40	131.5	142.8	15.5	16.3	108.60	136.63	0.881	0.653
	60	135.5	146.9	16.7	17.9	122.48	123.2	1.090	1.021
50 ppm	Control	122.6	132.7	14.2	14.5	114.77	114.96	0.851	0.760
	20	129.5	146.6	17.2	16.8	121.33	127.66	0.970	0.926
	40	137.7	151.8	16.7	17.3	142.10	134.71	1.133	0.937
	60 kg	144.7	155.3	18.8	19.4	141.11	148.10	1.160	1.247
100 ppm	Control	127.1	129.0	13.4	14.1	100.43	105.26	0.823	0.666
	20	134.1	142.1	17.4	16.5	117.86	116.48	0.921	0.850
	40	140.3	145.8	17.8	15.6	136.63	126.85	0.983	0.9333
	60	142.9	149.9	18.0	18.9	123.2	138.35	1.086	1.230
L.S.D. at 5%		N.S	N.S	N.S	N.S	N.S	N.S	0.179	0.155

Regarding, the effect of slow release nitrogen fertilizers rates, the same data in Table (2) reveal that application of slow release nitrogen fertilizers rates had significant increases in all studied parameters of vegetative growth in both seasons. In this connection increasing the rate of applied sulfur coated urea "SCU", from 20 to 60 kg N/fed was associated with marked simulative effects on plant growth. The application of 60 kg N/fed. sulfur coated urea "SCU",were superior, they significantly increased plant length, number of branches, leaves area and shoot dry weight per plant, compared with control treatment, in both seasons. These results could be attributed to the great role of the "SCU", contain N–element plus S–element. N and S elements are presented in the molecule of most amino acids, this in turn, stimulating division and elongation of cells and hence plant growth. The obtained data are in harmony with those of Gad El-Hak and Abdel-Mageed (2000), Sang *et al.* (2001) and Ezzat and Abd El-Hameed (2010).

As for the interaction effects, it is obvious from the same data in Table (2) that all treatments spayed with mixture of micronutrients levels were generally more effective in the presence than in the absence of sulfur coated urea "SCU". In this regard, plants sprayed with micronutrients at 50ppm and application with 60 kgN/fed. sulfur coated urea "SCU" gave the highest values of plant growth in both seasons compared with the other treatments.

2-Yield and its components:

Data illustrated in Table (3) show the effect of foliar spray with mixture of micronutrients and slow release nitrogen fertilizers rates and their interactions on yield and its components of sweet potato. Such data indicate that foliar spray with micronutrients at the 50ppm was generally beneficial than the other treatments. Moreover, this treatment significantly increased total yield, marketable yield and tuber root length in both seasons. However, tuber root diameter was significantly affected by foliar spray with micronutrients in the second season only. Meanwhile, weight of tuber root was not significantly affected in both seasons. The improving effect of Zn, Mn and Fe on yield and its components might be attributed to their positive role on enhancing photosynthesis, biosynthesis of proteins and carbohydrate assimilation diverted to the tuber roots (Marschner, 1995). Also, may be resulted from their effects on increasing vegetative growth of plant, which subsequently replicated positively on the physical properties of root tubers. This is in coincidence with the findings of Saif ELDeen (2005) and Abd El-Baky *et.al.* (2010) on sweet potato, Nofal (1998) on potato plants, where they found that yield and its components increased markedly by foliar spray of micronutrients compared with the untreated plants.

As for the effect of slow release nitrogen fertilizers rates, data in Table (3) indicate that total yield and its components were better with applied slow release nitrogen fertilizers rates to plants comparing with the untreated plants. Moreover, slow release nitrogen fertilizers at 60 kg N/fed. Sulfur coated urea "SCU" was more useful treatment to increasing total yield and improving its components than the other treatments. These increases might be due to the fact that SCU contain nitrogen and sulfur elements, and both elements are presented in the molecule of most amino acids and protein.

Also, the role of both elements in several biochemical processes that related to plant growth in addition sulfur may also decrease the soil pH, so resulting in increasing the available form of most nutrients, especially micro-elements (Marschner, 1995).

Table (3): Yield and Tuber root characters of sweet potato plant as affected by foliar spry with mixture of micronutrients and slow release nitrogen fertilizers rates and their interactions during 2012 (S1) and 2013 (S2) seasons.

Characters / Treatments		Total yield (ton/fed)		Marketable yield (ton/fed)		Tuber root characters					
						Weight		Length		Diameter	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Micronutrients- rates											
Control		9.269	10.27	8.265	9.237	201.	205.	16.	15.	4.9	3.4
50ppm		9.984	11.37	9.049	10.35	206.	208.	20.	17.	5.2	5.4
100ppm		9.697	10.42	8.973	9.421	203.	207.	17.	17.	5.2	4.8
LSD at 5%		0.472	0.514	0.409	0.472	N.S	N.S	2.2	1.1	N.S	0.7
Sulfur coated urea "SCU"											
Control		6.352	8.058	5.311	6.614	178.	181.	14.	14.	4.5	4.0
20 kg N/fed.		9.070	9.932	8.311	9.01	195.	196.	15.	16.	5.1	4.4
40 kg N/fed.		10.37	11.70	9.575	10.90	211.	218.	18.	16.	5.3	4.8
60 kg N/fed.		12.79	13.07	11.84	12.15	228.	232.	22.	18.	5.7	5.0
LSD at 5%		0.544	1.026	0.503	1.027	14.9	16.5	1.3	0.7	N.S	0.3
Interactions:											
Micro	SCU kgN/fed.										
Control	Control	6.698	7.548	5.622	6.015	173.	190.	14.	13.	4.5	4.2
	20	8.459	9.221	7.448	8.298	189.	205.	15.	14.	5.1	4.5
	40	9.618	11.52	8.743	10.78	216.	206.	17.	15.	4.8	4.9
	60	12.30	12.82	11.24	11.85	226.	231.	20.	16.	5.5	5.6
50 ppm	Control	6.077	8.609	5.047	7.185	176.	173.	15.	15.	4.2	4.8
	20	9.523	10.90	8.309	9.972	191.	190.	16.	16.	5.1	5.3
	40	10.80	12.25	10.04	11.46	224.	222.	22.	17.	5.7	5.6
	60 kg	13.53	13.75	12.71	12.79	233.	234.	25.	19.	5.8	6.0
100 ppm	Control	6.281	8.016	5.264	6.642	186.	179.	14.	14.	4.7	3.0
	20	9.230	9.673	8.876	8.760	205.	193.	15.	16.	5.0	3.1
	40	10.71	11.34	9.935	10.46	195.	226.	16.	17.	5.3	4.0
	60	12.56	12.64	11.56	11.81	225.	231.	23.	19.	5.7	3.3
L.S.D. at 5%		0.943	N.S	0.871	N.S	N.S	N.S	2.2	N.S	N.S	N.S

In this respect, Worthington *et al*. (2007) found that treatments potato plants in controlled release fertilizer produced significantly higher marketable tuber yields in both seasons compared with control.

Regarding the interaction effects, it is clear from data in Table (3) that the interactions between foliar spray with mixture of micronutrients and slow release nitrogen fertilizers rates had a significant effect on total yield, marketable yield and tuber root length in the first season only while, weight and diameter of tuber root were not significantly affected in both seasons. In general, plants sprayed with micronutrients at 50ppm and application with 60 kg N/fed. Sulfur coated urea "SCU" produced the highest values.

3- Chemical constituents:

Data in Table (4) show the effect of foliar spray with micronutrients and slow release nitrogen fertilizers rates and their interactions on element concentrations of sweet potato i.e., N, P, K, Fe, Zn and Mn.

Table (4): Chemical constituents of sweet potato plant as affected by foliar spry with micronutrients and slow release nitrogen fertilizers rates and their interactions during 2012 (S1) and 2013 (S2) seasons.

Characters / Treatments		N%		P%		K%		Fe		Zn		Mn	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Micronutrient-rates													
Control		1.19	1.16	0.201	0.187	1.74	1.98	168.4	173.4	20.0	21.3	64.2	61.3
50ppm		1.23	1.25	0.213	0.194	1.91	2.19	181.1	183.6	24.3	24.5	75.1	71.25
100ppm		1.23	1.20	0.202	0.191	1.90	2.18	177.7	173.4	21.9	22.8	69.5	66.1
LSD at 5%		N.S	0.03	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
N- Rates "SCU"													
Control		1.08	1.02	0.167	0.150	1.44	1.57	147.8	149.5	14.5	17.2	51.0	48.4
20 kg N/fed.		1.18	1.12	0.201	0.193	1.69	2.08	174.2	175.2	19.3	22.3	68.4	64.0
40 kg N/fed.		1.24	1.27	0.222	0.205	2.03	2.31	187.6	191.7	25.9	25.7	77.7	74.6
60 kg N/fed.		1.37	1.41	0.233	0.215	2.23	2.51	197.8	197.0	28.6	26.4	81.3	77.7
LSD at 5%		0.46	0.05	0.012	N.S	0.23	0.30	19.2	17.3	5.1	3.1	10.8	10.1
Interactions:													
Micro	SCU kgN/fed.												
Control	Control	1.06	0.97	0.155	0.137	1.32	1.44	143.0	147.0	13.0	15.6	44.3	41.3
	20	1.15	1.07	0.191	0.184	1.48	1.84	163.7	166.7	15.3	19.7	59.7	56.7
	40	1.23	1.25	0.223	0.202	1.98	2.15	177.3	193.6	23.3	23.3	72.7	69.3
	60	1.34	1.38	0.238	0.224	2.19	2.48	189.6	205.0	28.3	26.7	80.3	78.0
50 ppm	Control	1.07	1.07	0.180	0.157	1.51	1.60	148.0	158.0	16.0	19.0	53.7	52.6
	20	1.20	1.15	0.210	0.189	1.73	2.07	187.0	178.7	19.7	23.7	75.0	69.0
	40	1.24	1.29	0.227	0.209	2.09	2.44	196.3	193.7	28.3	27.0	84.0	79.7
	60 kg fed.	1.41	1.49	0.237	0.222	2.29	2.66	207.3	204.0	33.3	28.7	88.0	83.7
100 ppm	Control	1.11	1.04	0.168	0.157	1.49	1.67	152.7	143.7	14.6	17.0	55.0	51.3
	20	1.18	1.13	0.202	0.205	1.87	2.33	172.0	180.3	23.0	23.7	70.7	66.3
	40	1.24	1.27	0.216	0.203	2.03	2.35	190.0	187.7	26.0	26.7	76.6	75.0
	60	1.37	1.37	0.223	0.198	2.21	2.39	196.3	182.0	24.0	24.0	75.6	71.6
L.S.D. at 5%		N.S	0.9	N.S	N.S	N.S	N.S	N.S	N.S	N.SN.S	N.S	N.S	N.S

From such data, indicate that foliar spray with mixture of micronutrients at the 50ppm was generally beneficial than the other treatments. Moreover, this treatment it is evident that foliar spray with micronutrients had a significant effect on N% in the first season only. Meanwhile, P%, K%, Fe, Zn and Mn were not significantly affected in both seasons of study. These increases in elemental constituents of tuber roots of sweet potato may be due to the effect of micronutrients on stimulating biological activities, i.e., enzyme activity, chlorophyll synthesis, rate of translocation of photosynthetic products and increased nutrient uptake through roots after foliar fertilization (Follett *et al*., 1987). These results agreed with reported by Abd El-Baky *et al.* (2010) on sweet potato, found that carotenoids, total sugars, total carbohydrates and crude protein were increased with increasing zinc application rate.

Concerning the effect of slow release nitrogen fertilizers rates, data in Table (4) show that all concentrations of elements i.e., N%, K%, Fe, Zn and Mn on sweet potato plant were significantly increased due to applying slow release nitrogen fertilizers rates to plants compared with the untreated plants in both seasons of study except of P% in the first season only. The highest values of chemical concentration were produced by plants treated with slow release nitrogen fertilizers at 60 kg N/fed. sulfur coated urea "SCU" in both seasons. These results agreed with those reported by Gouda (2008) and Ezzat and Abd El-Hameed (2010).

As for the interaction effects, it is obvious from the same data in Table (4) that all treatments sprayed with micronutrients levels were generally more effective in the presence than in the absence of sulfur coated urea "SCU". In this regard, plants sprayed with mixture of micronutrients at 50 ppm and supplied with 60 kg N/fed. sulfur coated urea "SCU" gave the highest values of chemical concentration in both seasons compared with the other treatments but was not significant.

4- Organic compositions:

Data presented in Table (5) show the effect of foliar spray with mixture of micronutrients and slow release nitrogen fertilizers rates and their interactions on organic compositions of sweet potato plants.

Concerning the effect of foliar spry with mixture of micronutrients, it is clear from such data in Table (5) that, Non reducing sugar% and carotene significantly affected in both seasons of study. Meanwhile, Total carbohydrates% and reducing sugar% were not significantly affected in both seasons; the highest value was recorded by foliar sprayed with mixture of micronutrients at 50ppm. Meanwhile, the lowest vegetative growth characters were recorded by control treatment (foliar spraying with tap water). The positive effect of micronutrients on organic composition of fresh cured roots may be due to their involvement in one or more of important biological functions such as synthesis of chlorophyll, electron transport system, oxidation-reductio reactions, protein synthesis, degradation and Co-enzyme of several important enzymes (Tisdale *et al*., 1985). Such functions would directly or indirectly contribute to increasing organic compositions on tuber root of sweet potato. These results agreed with reported by Saif ELDeen (2005), Abd El-Baky *et al.* (2010), on sweet potato, who found that spraying plants with mixture of micronutrients increased organic compositions on tuber root of sweet potato as compared with the untreated ones.

Table (5): Organic compositions of sweet potato plant as affected by foliar spry with micronutrients and slow release nitrogen fertilizers rates and their interactions during 2012 (S1) and 2013 (S2) seasons.

Characters / Treatments		Total carbohydrates%		Reducing sugar%		Non Reducing sugar%		Carotene%	
		S1	S2	S1	S2	S1	S2	S1	S2
Micronutrients- rates									
Control		62.11	61.96	7.34	7.24	2.56	2.68	0.84	0.67
50ppm		66.01	67.55	7.68	7.61	3.13	3.26	0.90	0.81
100ppm		65.79	64.21	7.42	7.52	2.81	3.00	0.69	0.79
LSD at 5%		N.S	N.S	N.S	N.S	0.19	0.22	0.09	0.06
N-rates “SCU”									
Control		57.94	56.20	6.64	6.72	2.30	2.41	0.61	0.58
20 kg N/fed.		63.46	64.22	7.35	7.27	2.75	2.86	0.79	0.73
40 kg N/fed.		67.40	68.03	7.93	7.83	3.05	3.21	0.89	0.83
60 kg N/fed.		69.72	69.83	7.99	8.00	3.23	3.44	0.94	0.88
LSD at 5%		3.35	4.66	0.49	0.48	0.37	0.31	0.10	0.11
Interactions:									
Micro	SCU kgN/fed.								
Control	Control	54.45	58.25	6.55	6.47	2.00	2.32	0.59	0.47
	20	59.81	61.98	7.08	6.90	2.37	2.75	0.81	0.62
	40	64.18	66.51	7.61	7.53	2.76	3.24	0.93	0.76
	60	69.97	70.09	8.12	8.07	3.13	3.68	1.03	0.84
50 ppm	Control	58.49	61.07	6.72	6.80	2.73	2.55	0.66	0.64
	20	64.44	66.33	7.51	7.48	3.14	3.13	0.88	0.78
	40	69.68	69.89	8.11	8.01	3.31	3.54	0.99	0.87
	60	71.38	72.91	8.37	8.14	3.34	3.81	1.07	0.94
100 ppm	Control	60.88	49.28	6.67	6.88	2.17	2.37	0.57	0.63
	20	66.13	64.35	7.45	7.42	2.74	2.69	0.69	0.78
	40	68.35	67.69	8.07	7.96	3.07	2.85	0.76	0.86
	60	67.81	66.50	7.50	7.79	3.23	2.83	0.74	0.88
L.S.D. at 5%		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Regarding, the effect of slow release nitrogen fertilizers rates, the same data in Table (5) reveal that application of slow release nitrogen fertilizers rates had significant increases in all studied parameters of organic compositions in both seasons. In this connection increasing the rate of applied sulfur coated urea "SCU", from 20 to 60 kg N/fed was associated with marked simulative effects on organic compositions. The application of 60 kg N/ fed. sulfur coated urea "SCU", were superior, they significantly increased total carbohydrates, reducing sugar, non reducing sugar% and carotene content, compared with control treatment, in both seasons. These results could be attributed to the great role of the "SCU", contain N-element plus S-element. N and S elements are presented in the molecule of most amino acids and N is a main constituent of many organic compounds in plants, such as proteins, enzymes, pigments, hormones, vitamins and nucleic acids (Marschner, 1995).

The obtained data are in harmony with Ezzat and Abd El-Hameed (2010), on potato plant.

Regarding the interaction effects, it is clear from data in Table (5) that the interactions between foliar spray with mixture of micronutrients and slow release nitrogen fertilizers rates had insignificant effect on total carbohydrates, reducing sugar, non reducing sugar% and carotene content in both seasons. In general, plants sprayed with micronutrients at 50ppm and application with 60 kg N/fed sulfur coated urea "SCU" produced the highest values.

REFERENCES

Abbady, K. A.; A. B. Barakat; M. I. El-Mallah and A. A. Khatab (1997). The Effect of some slow–release fertilizers on onion yield and successive sweet corn growth. 1- The effect on onion bulb yield, bulb quality and chemical constituents. Egypt. J. Appl. Sci.,12 (3):245 – 261.

Abd El-Baky, M. M. H.; A. A. Ahmed; M. A. El-Nemr and M. F. Zaki (2010). Effect of Potassium Fertilizer and Foliar Zinc Application on Yield and Quality of Sweet Potato. Research J. of Agri. and Biol. Sci., 6: 386-394.

Abou El-Khair1, E. E.; I. A.S. Al-Esaily and N. M. El-Sarkassy (2011). Physiological response of garlic plant grown in sandy soil to foliar spray with iron, zinc and manganese either individual or in mixture form. Minufiya J. Agric. Res., 36(2): 409-426.

Allen, S. E. (1984). Slow-release nitrogen-fertilizers. *In*: nitrogen in crop Production, pp. 195-206. National Fertilizers Development Center- South Sagoe Road, Madison, WI-53711, USA.

A.O.A.C (Association of Official Analytical Chemists) (1990). “Official Methods of Analysis”. 15th Ed., Washington, DC, USA.

Black, C. A. (1965). Methods of Soil Analysis. Part 1 and 2. Amer. Soc. Agron. Inc., Madison, Wisconsin, USA.

Booth, U. H. (1958). Extraction and estamination of Carotene. Univ. Cambridge and medical Res. Cuuncil Dunn. National Lab., Cambridge, England.

Brown, J. D.; O. Lilleland (1946). Rapid determination of potassium and sodium in plant material and soil extracts by flam photometry. Proc. Amer. Soci. Hort. Sci., 48 : 341 – 346.

Chapman, H. D. and P. F. Partt (1961). Methods of analysis for soil, plant and water. Department of soil and plant nutrition, Univ. of California, Citrus Exp. Sta. Reverside, California, USA .

Chatzoudis, G. K., and G. N. Valkanas (1995). Monitoring the combined action of controlled release fertilizers and soil conditioner in soil. Comm. Soil. Sci. Plant. Anal., 26:2099.

Chien, S.H., L.I. Prochnow, and H. Cantarella (2009). Recent developments of fertilizer production and use to improve nutrient efficiency and minimize environmental impacts. Advances in Agronomy,102: 267-322.

Dubois, M.; A. Gilles; J. K. Homilton; P. A. Rebers and P. A. Smith (1956). A colorimetric method for determination of sugar and related substances. Anal. Chem., 28: 350-356.

El-Haddad, M.E.; Y.Z. Ishac and M.I. Mostafa (1993). The role of biofertilizers in reducing agricultural costs , decreasing environmental pollution and raising crop yields . Arab Univ. J. Agri. Sci. Ain Shams Univ.,1(1) : 147-195, Egypt .

El-Hawary, N.A. (1999). Effect of a new macro-micronutrients formulation on the yield production of some field and vegetable crops. J. Agric. Sci. Mansoura Univ., 24 (9): 5175-5186.

El-Mallah, M. I. ; I. A. Ibrahim ; A. A. Darwish and K. A. Abbady (1998). Efficiency of slow–release and fast release N–fertilizers on spinach (growth and maturity quality) and the residual effect on corn. Egypt. J. Appl. Sci., 31 (4) : 292 – 306 .

El-Moursi, A. and A.I. Rezk. (1987). Response of potato plants to different forms of micronutrient foliar fertilizers. Anna. Agric. Sci. Moshtohor, 25 (1): 521– 531.

El-Morsy, A.H.A. (2005). Effect of sulpher levels and foliar application of certain micronutrients on garlic (*Allium sativum* L.). The Sixth Arabian Horticulture Conference, Ismailia, Egypt, March 20-22, 457-467.

El-Morsy, A.H.A. and M.M.B. Shokr (2005). Effect of some nitrogen levels and biofertilizers on productivity of garlic and pea intrcropped. J. Agric. Sci. Mansoura Univ., 30 (4): 1185 – 1201.

Ezzat, A.S and.A.M; Abd El-Hameed (2010). Effect of slow release nitrogen fertilizers on productivity and quality of potato (*solanum tuberosum* l.). J. Plant Production, Mansoura Univ., Vol. 1 (2): 169 - 184 .

Fageria, N.K., and V.C. Baligar (2005). Enhancing nitrogen use efficiency in crop plants. Advances in Agronomy, 88: 97-185.

Follett, R.H., L.S. Murphy and R.L. Danahue (1987). fertilizers and soil Amendments. Prentice – Hall, Englewood Cliffs. NJ. USA

Gad El-Hak, S. H. and Y.T. Abd El-Mageed (2000). Effect of nitrogen source on growth, yield, nirate content and storage ability of two garlic cultivars. Minia J. Agric. Res. & Devel., 20 (1) : 115 – 139.

Gouda A. E. A. I. (2008). Effect of some nitrogenous and phosphatic fertilizers sources and va-mycorrhiza inoculum on growth, productivity and storability of garlic (*Allium sativum* L.) Ph. D. Thesis. Fac. Agric., Mansoura Univ.,187 pp

Grang, G. R. (1963). United State standards for grades of sweet potatoes. USDA-ARS. Washington D.C.

John, M. K.(1970). Colorimetric determination of phosphorus in soil and plant material with ascorbic acid. Soil Sci., 109: 214-220 .

Koller, H.R. (1972). Leaf area–leaf weight relationship in the soybean canopy.Crop Sci., 12: 180-183.

Marschner, H. (1995). Mineral Nutrition of Higher Plants. 2nd Ed. Academic Press, Harcourt Brace and Company, Publishers. London, New York, Tokyo, pp 864.

Michel, U.; G. K. Gilles; P. Hamilton and F. Smith (1956). Colorimetric method for determination of sugar and related substances. Analytic chemistry, 28: 17-24.

Nijjar, G.S. (1985). Nutritions of fruit tress. Mrs Usha Raj Kumar for Kxlyaml Publishers, New Delhi: 173-270.

Nofal, O. A. (1998).Effect of micronutrient foliar fertilizers on yield of some potato varieties, J. Agric. Mansoura Univi. 23 (12) :5359-5366.

Nyiraneza, J. and S. Snapp (2007). Integrated management of inorganic and organic nitrogen and efficiency in potato systems. Soil Sci. Soc. Amer. J., 71: 1508-1515.

Omran, M.S., T.M. Waly, M.M. Shinnawi and M.M. El-Sayed (1991). Effect of macro and micro-nutrients application on yield and nutrient content of potato. Egypt. J. Soil Sci., 31 (1): 27-42.

Radwan, E.A. and A.A. Tawfik (2004). Effect of Sulphur, Manganese and zinc on growth, yield and quality of potato (*Solanum tuberoium* L.). J. Agric. Sci. Mansoura Univ., 29 (3): 1423-1431.

Saif-El-Deen, U. M. (2000). Studies on bio and chemical fertilization on sweet potato "Ipomoea batatas, L.". M.S. Thesis, Fac. Agric., Fac. Agric., Mansoura Univ., 155pp.., Egypt.

Saif–El-Deen, U. M. (2005). Effect of phosphate fertilization and foliar application of some micronutrients on growth, yield and quality of sweet potato (*Ipomoea batata* L.). Ph. D. Thesis, Fac. Agric., Sues Canal Univ., 171pp. Egypt.

Sang, S. Y.; C. I. Hu; C. B. Choon and C. W. Yul (2001). Effects of applying slow-release fertilizer on southern type garlic (*Allium sativum* L.) cultivation. Korean J. Hort. Sci. and Tech., 19 (4): 471-475.

Shaviv, A. (2001). Advances in controlled-release fertilizers. Advances Agron., 71, 1-49.

Snedecor, G. W., and W. G. Cochran. (1980). Statistical Methods. 7th Ed. 2nd Printing, Iowa State. Univ. Press, Ame., USA, pp 507.

Srivastva, P.C. and U.C. Gupta (1996). Trace elements : A concern. In Trace elements in crop production. Science Publishers, Inc; Lebanon, NH 03766, USA.

Tisdale, SL; WL Nelson and JD Beaton, (1984). Soil fertility and fertilizers, 4th ed, McMillan Publishing company, New York.

Worthington, C. M., K. M. Portier, J. M. White, R. S. Mylavarapu, T. A. Obreza, W. M. Stall, and C. M. Hutchinson (2007). Potato (*Solanum tuberosum* L.) yield and internal heat necrosis incidence under controlled-release and soluble nitrogen sources and leaching irrigation events. Amer. J. Potato Res., 84: 403-413.

تـأثير الـرش الـورقى بالعناصـر الصـغرى والتسـميد بالأسـمدة النيتروجينيـة بطيئـة التحلل على الإنتاجية والجودة في البطاطا.

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أجريت تجربتان حقليتان بالمزرعة البحثية بالبرامون محافظة الدقهلية مصر والتابعة لمعهد بحوث البساتين مركز البحوث الزراعية في الموسميين المتعاقبين ٢٠١٢، ٢٠١٣ م بهدف دراسة استجابة محصول البطاطا (صنف أبيس) للرش الورقى بمخلوط العناصر الصغرى (حديد ،زنك ،منجنيز) عند تركيزات صفر ،٥٠ ، ١٠٠جزء فى المليون والأسمدة بطيئة التيسر(اليوريا المغلفة بالكبريت ٣٧.٨ % نتروجين) عند تركيزات صفر و٢٠ و٤٠ و٦٠ كجم للفدان بصورة منفردة والتفاعل فيما بينهما وتأثير ذلك علي الإنتاجية والجودة فى البطاطا .

ويمكن تلخيص أهم النتائج المتحصل عليها كما يلي:

بصفة عامة أوضحت النتائج أن الرش الورقى بمخلوط العناصر الصغرى كان أفضل من النباتات الغير معاملة ،زيادة التركيزات من صفر حتى ٥٠، ١٠٠جزء فى المليون أدت إلى زيادات معنوية فى طول النبات والوزن الجاف والمساحة الورقية بالإضافة إلى المحصول الكلى والتسويقى ووزن وطول وقطر الجذرالدرنى فى كلا موسمى الدراسة ،بينما محتوى النتروجين زاد معنوياً فى الموسم الأول فقط ، الرش الورقى بمخلوط العناصر الصغرى أدى أيضاً إلى زيادة فى السكريات المختزلة والكاروتين فى كلا موسمى الدراسة، الرش الورقى بمخلوط العناصر الصغرى عند تركيز ٥٠ جزء فى المليون كان من أفضل المعاملات فى معظم الصفات تحت الدراسة .

ومن ناحية أخرى أدى اضافة الأسمدة بطيئة الذوبان إلى زيادات معنوية فى طول النبات والوزن الجاف والمساحة الورقية بالإضافة إلى المحصول الكلى والتسويقى ووزن وطول وقطر الجذرالدرنى وكذلك المحتويات الكيماوية والعضوية فى الجذر الدرنى فى كلا موسمى الدراسة ، اضافة ٦٠ كجم نتروجين للفدان من اليوريا المغلفه بالكبريت كانت متفوقة فى معظم الصفات تحت الدراسة .

اوضحت النتائج ان معاملة التفاعل باستخدام الرش الورقى بمخلوط العناصر الصغرى عند تركيز ٥٠ جزء فى المليون مع إضافة ٦٠ كجم نتروجين للفدان من اليوريا المغلفه بالكبريت أعطت أعلى القيم طول النبات والوزن الجاف والمساحة الورقية بالإضافة إلى المحصول الكلى والتسويقى و وزن وطول وقطر الجذرالدرنى وكذلك المحتويات الكيماوية والعضوية فى الجذر الدرنى فى كلا موسمى الدراسة بالمقارنة بالكنترول .

وبناءً على ماتقدم، يمكن التوصية باستخدام المعاملة ٥٠ جزء فى المليون مع إضافة ٦٠ كجم نتروجين للفدان من اليوريا المغلفه بالكبريت لرفع إنتاجية البطاطا وتحسين جودة الجذور الدرنية تحت الظروف المشابهة لظروف هذا البحث.