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ROLE OF MICRONUTRIENTS AND ANTIOXIDANTS APPLICATION IN STIMULATING GROWTH AND YIELD OF FRESH EDIBLE VEGETABLES

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ABSTRACT

A pot experiment was conducted at the greenhouse of Fac. of Agric., Mansoura University during the successive winter seasons of 2009/ 2010. This work aimed to evaluate the effect of different nitrogen levels in the presence of (Na -Molybdate (10ppm), boron (50ppm) , Na -salsalate (10ppm) and Ascorbic acid (250ppm)) as foliar application on yield and chemical composition of lettuce (*lactuca sativa, L., CV*, *balady)* vegetables. As fore soil used in this investigation ; 24 treatments were arranged in a split- split block design with three replicates, which were the simple possible combination among two sources of N fertilizers (ammonium nitrate 33.5%N and ammonium sulfate 20.5%N) three levels of N application (100, 125 % and 150%) of recommended doses(RD) and four treatments of foliar spraying (Na -Molybdate (10ppm), boron (50ppm) , Na -salsalate (10ppm) and Ascorbic acid (250ppm)))

The obtained results can be summarized as follow:

- Spraying of micronutrients and antioxidants either in a single form or in combination with mineral fertilization led to a positive effect on the growth and yield of lettuce plants.
- The accumulation of nitrate and nitrite in lettuce fresh leaves increased as the level of mineral fertilizers increased. Foliar (Na -Molybdate (10ppm), boron (50ppm) , Na -salsalate (10ppm) and Ascorbic acid (250ppm)) resulted in pronounces decrease in the values of NO_3-N and NO_2-N in lettuce plant.
- Under the same condition of this investigation, it could be recommended that; soil addition of N fertilizers at the rate of 100% from the recommended doses for lettuce plant coupled with foliar application of Molybdate-Na is considered as the optimum treatment for producing a safe yield of lettuce plant.

Keywords: Antioxidant, mineral fertilizers, nitrate, nitrite, lettuce plant.

INTRODUCTION

Lettuce (*Lactuca sativa, L.*) is one of the most important leafy vegetables of high nutrient value (vitamin A, B1, B2 and C), as well as calcium and iron. The concentration of nitrogen compounds in fresh yield of lettuce is an important parameter of the lettuce quality beside the photometrical characteristics for a number of reasons. Nitrate, once ingested may be converted to nitrate, resulting in the formation of acompound, harmful to human health (methaemoglobinaemia and nitrosamines (Reinink and greonwold, 1988).

In Egypt, farmers consume large amounts of N, P and K mineral fertilizers per fedden soil area to increase the yield of leafy vegetables without any care of the adverse residual effects on the quality of these crops as well as the quality of agricultural ecosystem. Over usage of mineral fertilizers contributes to several environmental problems such as eutrophication and causing an increase in plant absorption of some nutrients and compounds such as nitrate which caused a toxic effect for plants and many hazardous for the human health**.**

It is currently accepted that intake of nitrate implies a risk of methaemoglobinaemia (blue baby syndrome) for young infants. The hemoglobin molecule in the red blood cells has the important function of transporting oxygen. Metheamoglobin is an oxidized form of hemoglobin that is oxidized, from the Fe^{+2} to the Fe^{+3} form. If the Metheamoglobin level is abnormally high, the condition is known as Metheamoglobin aimed (Sulotto *et al*., 1994). For instance, Avery (1999) defuses Metheamoglobin aimed as the condition which more than 1% of hemoglobin is oxidized to Metheamoglobin. Nitrate itself is convert to nitrite – doesn't have the ability to transform hemoglobin into Metheamoglobin. Nitrite oxidation of oxyhaemoglobin is reported according to Kosaka *et al.,* equation (1979) as follow:

$$4HbO_2 + 4NO_2^- + 4\,H^+ \rightarrow 4Hb^+ + 4NO_3^- + O_2 + 2H_2O$$

(HbO_2; Oxyhaemoglobin; Hb^+; Metheamoglobin**)**

The occurrence of nitrate in food (notably in vegetables), whatever its origin, enters the blood, is secreted with saliva, and part of nitrate is then reduced to nitrite by bacteria in the mouth. The saliva is swallowed; hence the nitrite enters the normally acidic stomach. Nitrite is reactive under acidic conditions. It can decompose to form nitric oxide, and it can react with a variety of organic compounds in food and in gastuc secretions to form nitroso compounds (NOC5). Most NOC5 is likely to be responsible for a significant proportion of several cancers.

Many investigators indicated that using micronutrients led to an increase in fresh, dry yield and total yield of most leafy vegetables. The increases in plant growth characters due to foliar application of micronutrients may be attributed to the role of these nutrients on plant bioactivities. Molybdenum increased growth, yield and chlorophyll content of some vegetable plants (Kheir, et al. 1991; Kotour, 1998; Chattopadhyay and Mukhopadhyay, 2004). Spraying plants with molybdenum increased nutrient contents, especially N, P, K and Mo (Kotour, 1998; Abd Allah, 2001; El-Sawah and Gadallah, 2004; El-Banna and Abd El-Salam, 2005).

Several studies have pointed out the essentiality of B for N_2 fixation in the heterocyst of the cyan bacterium *Anabaena* PCC 7119 (Mateo *et al*. 1986; García- González *et al*. 1990) and in the vesicles of actinomycetes of the genus *Frankia* (Bolaños *et al* 2002). Both types of microorganisms require B for the stability of the envelopes that protect nitrogen's from inactivation by oxygen when grown under N_2- fixing conditions. Moreover, it has been described a lower number of developed nodules and capacity to fix N_2 in legumes under B deficiency**,** which could be attributable to the possible role of B in *Rhizobium*-legume cell surface interaction. Specifically, B is needed for the targeting of nodule-specific plant derived glycoprotein's (Bolaños *et al* 2001) that are crucial as signals for bacteroid differentiation into a N_2-fixing form (Bolaños *et al*. 2004). In addition, the cell walls of B deficient nodules have low levels of hydroxyproline- proline-rich proteins such as ENOD2, which results in a higher oxygen diffusion into the nodules and the consequent inactivation of nitrogenase (Bonilla *et al*. 1997). There are several reports on the possible involvement of B in nitrogen assimilation. For instance, a reduced nitrate reductase nitrate reductase (NR) activity and enhanced accumulation of nitrate have been described in B deficient plants

(Shen *et al.* 1993), these effects being attributable to the possible role of B in the de novo synthesis of the NR protein or facilitation of nitrate absorption (Ruiz *et al*. (1998).

Antioxidant such as (ascorbic acid and salicylic acid) In recent years, application of exogenous SA at non-toxic concentrations to plants has been shown to be effective in the regulation number of processes, such as biotic and a biotic stresses (Ananieva *et al*., 2004; Eraslan *et al*., 2007; Janda *et al*., 2007). Exogenous SA can protect and enhance the enzymes of nitrate metabolism under stressful environments (Hayat *et al* 2008).

The aims of this research are to determine:

1- The effect of the high doses and different nitrogen sources application "nitrate and ammonium forms" on lettuce yield.

2- The effect of some micronutrients such as (Bo and Mo) as foliar application in the presence of N rates on yield, plant height, fresh weight, dry weight and nitrate accumulation in lettuce plants.

3-The effect of antioxidants such as (ascorbic acid and salicylic acid) as foliar application in the presence of N rates on yield, plant high, fresh weight, dry weight and nitrate accumulation for lettuce plants.

MATERIALS AND METHODS

A pot experiments was conducted under the greenhouse of Fac. of Agric., Mansoura Univ. during the winter seasons of 2009-2010 to estimate the effect of N fertilization (levels and forms) as well as foliar application of some micronutrients and antioxidanst on growth and chemical compositions of lettuce plants.

Experimental Soil:

The soil used was taken from the surface layer (0-20 cm) of a clay soil from special farm located near El-Mansoura city, Dakahlia Governorate. Soil sample was air dried and analyzed to determine some physical and chemical properties as shown in Table 1.

Twenty four treatments were arranged in a split split block design, which were the simple possible combination among two forms of N fertilizers (ammonium nitrate 33.5%N and ammonium sulfate 20.5%N) were randomly located in the main plot, 3levels of N fertilization (40, 50and 60 kg N/fed), were devoted in sub-plot and 4treatments foliar application of micronutrients and antioxidants were arranged in sub-sub plot as follow:

1-Ascorbic acid at the rate of 250ppm.

2- Sodium Salsalate at the rate of 10 ppm.

3- Boron as borax at the rate of 50 ppm.

4-Mo as sodium molybdate (46% Mo) at the rate of 10 ppm.

Fertilization: Ammonium sulphate (20.5 % N), calcium super-phosphate (7 % P) and potassium sulphate (40 % K) were used as a source of N, P and K, respectively. Three treatments of, N, mineral fertilization at the rates of (1.50, 1.25 and 100 %) from the recommended doses for leafy vegetables i.e. [200 Kg ammonium sulphate, 150 Kg calcium super-phosphate and 100 Kg potassium sulphate/fed].

Each dose of N, P and K fertilization was splitted into two amounts; one was added after 15 days from transplanting and the other after two weeks later.

Foliar application of micronutrients and antioxidants was conducted in two times; the first dose was after 30 days from transplanting and the second dose was added after 7 days at the rate of 100 ml pot-1 in each added.

All cultivation processes were carried out according to the recommendation of the Egyptian ministry of agriculture.

Table 1: some physical and chemical properties of the experimental soil:

Soil properties		**Values**
Soil physical properties		
Particle size distribution	**Sand**	23.63%
	Silt	29.75%
	Clay	46.62%
	Soil texture	Clay
E.C*.dS.m^{-1}(1:5)		1.02
PH**(1:2.5)		8.01
Organic matter (%)		2.1
Calcium carbonate, %		3.07
Soluble cations (meq/100g soil)	**Ca^{2+}**	2.40
	Mg^{2+}	0.65
	Na^{+}	2.00
	K^{+}	0.16
Soluble anions (meq/100g soil)	**CO_3^{2--}**	0
	HCO_3^{-}	1.10
	Cl^{-}	1.90
	SO_4^{2-}	2.20
Available nutrients (mg/kg)	**Nitrogen**	47
	Phosphorus	8
	Potassium	275
Available micronutrients (mg/kg)	**Mo*** **	0.48
	B	0.97
	Fe	10
	zn	3.8

*** Soil extraction 1:5 (soil: water)**
**** Soil suspension 1:2.5 (soil: water)**
***** extracted by DTPA.**

Cultivation: 72polyethylene pots ;(20 cm in diameter and 30 cm heights) were used where each pot was filled with 8 kg air dried soil. Two uniform seedling of lettuce (*lactuca sativa, L, cv.Balady*) were transplanted on January 12, 2009. All treatments were irrigated at the field capacity.

Experimental procedures: At harvesting stage (55 days after sowing three samples of plant foliage, and ten leaves were randomly taken from each pot were recorded. plant growth parameters expressed as; Fresh weight (g/Plant), dry weight (g / Plant) and Fresh yield (g/ Pot) were recorded. The oven dry plants of lettuce plant were wet digested to determine N, P and K In addition nitrate and nitrite.

Method of analysis: Mechanical analysis of the used soil was determined following the international pipette method (Hesse,1971).

Calcium carbonate, organic matter, available N, P, K, in soil were determined using the methods adopted by Piper (1950); Jackson (1967); Olsen and Sommers (1982) and Black (1965).

The electrical conductivity and soil reaction (pH) were measured according to the method of US Salinity Lab (1954) and Jackson (1967). Iron, manganese and molybdenum in the soil were extracted using DTPA and determined by an Atomic Absorption Spectrophotometer as described by Chapman and pratt (1961).

Plant analysis:

The oven dry materials of plant samples were ground and wet digested as described by Peterburgski (1968). The total Fe, Zn and Mo were determined using the techniques described by Pregle (1945) and Chapman and pratt (1961).

Nitrate and nitrite were measured by using a rapid method Singh (1988).

Statistical analysis: The statistical analysis of the collected data was done according to the method described by (Gomez and Gomez 1984) using LSD to compare the means of treatment values.

RESULTS AND DISCUSSION

1-Fresh & dry weight of lettuce plant and fresh yield:

Data presented at Table (2) illustrate the mean values of fresh and dry weight (g/plant) as well as fresh yield (g/pot) for lettuce plant as affected by foliar application, soil addition of mineral fertilizers and their interaction during 2009-2010 seasons.

Data reveal that; spraying of foliar application treatments significantly increased the mean values of all studied growth parameters. In this respect; foliar application of Molybdate-Na (10ppm) was superior for increasing these parameters followed by boron (50ppm), then Ascorbic acid (250ppm) then, salsalate Na (10ppm) and finally control treatment.

2- Plant height; cm for lettuce plant:

The average values of plant height of lettuce crops were not significantly increased as the rate of N mineral fertilization, increased as illustrated in Table 2.

Data also indicate that, at any form of N fertilizers under investigation foliar application of micronutrients and antioxidants significantly increased the average values of plant height of lettuce plants than the control treatment. The highest values were recorded for the plants received 125% of N fertilizers (ammonium sulphate) combined with Molybdate treatment.

It also can be noticed that; the foliar application of micronutrients and antioxidants as a single form significantly increased the average values of plant height for the lettuce crops studied than those obtained for the untreated one. In this respect; Molybdate application treatment was superior for increasing the values of plant height over the untreated one.

These results were in agreement with El-Sirafy (1990), Abdel-Razik (1996), Abdalla (1997), Bianco *et al.,* (1998), Cho *et al.,* (2000), Salman *et al.,* (2000), El-Dsoky (2003) Maftoun *et al.,* (2004), Tartoura *et al*., (2005), Lashin (2006), Rashwan (2006), Abd El-Wahab *et al*., (2007).

Table 2: Mean plant height, cm, Fresh & dry weight of lettuce plant and fresh yield as affected by mineral fertilization and some foliar addition.

Characterizes / Seasons / Treatments	D.G.L weight $g.plant^{-1}$	L.G.L weight $g.plant^{-1}$	Total fresh Weight $g.plant^{-1}$	Plant height CM	Dry weight $g.plant^{-1}$
Nitrogen application Form					
NO_4NO_3	172.13 b	124.12 b	296.25 b	32.20 b	61.65 b
$(NH_4)_2SO_4$	228.23 a	159.55 a	387.78 a	36.56 a	81.174 a
L.S.D at 0.05 %	6.19	11.96	18.05	3.67	3.84
Nitrogen application Rate					
100%	210.26 a	148.59 a	358.85 a	35.69 a	79.915 a
125%	201.68 b	146.05 a	347.73 b	33.68 a	76.56 b
150%	188.61 c	130.86 b	319.47 c	33.77 a	57.76 c
L.S.D at 0.05 %	1.88	6.94	7.35	N.S	1.25
Foliar application treatments					
0	133.72 e	90.82 e	224.53 e	28.77 d	47.895 e
A.A	196.52 c	142.33 c	338.85 c	34.73 b	70.618 c
Sa	162.72 d	117.72 d	280.44 d	31.46 c	57.243 d
B	236.83 b	163.18 b	400.02 b	36.02 b	82.14 b
Mo	271.13 a	195.11 a	466.25 a	40.92 a	99.154 a
L.S.D at 0.05 %	2.16	7.53	7.68	2.55	1.78

A.A: ascorbic acid 250ppm **B: borax 50 ppm**
Sa: sodium- salsalate10 ppm **Mo: Na – Molybdate 10 ppm**
D.G.L: dark green leaves **L.G.L: light green leaves**

From the results mentioned previously it can be concluded that; the increases in all growth parameter of the lettuce crops under investigation due to raising the rates of N fertilizers from 100 up to 150 % from the recommended doses may be attributed to the beneficial effect of these nutrients on stimulating the merestimutic activity for producing more tissues and organs and consequently the growth of plants. On the other hand; the inhibitory effect in fresh and dry yield of these crops due to increasing the rate of N addition from 100 to 150 % may be attributed to the slight increase in osmotic pressure of soil solution as a result of adding the highest rate of N in the close system of pots, (without drainage). Then, less water and nutrients were absorbed by the root system and, consequently fresh and dry yield were inhibited.

٣-NO_3-N and NO_2-N content in lettuce plant:

Data illustrated in Tables (4)and(5) show the effect of N fertilization forms, levels, foliar spraying of micronutrients and antioxidants and their interactions on nitrate and nitrite contents on fresh weight of lettuce plant at marketing stage.

Concerning the effect of nitrogen fertilizer forms, data revealed that nitrate and nitrite contents were significantly increased in plants treated with ammonium nitrate 33.5%N, while the lowest values were obtained for the ammonium sulfate 20.5%N.

Regarding the effect of mineral nitrogen fertilization, data at the same Table revealed that, soil addition of N fertilizers either at the rate of 100%, 125% or 150% from the recommended doses for lettuce plant sharply and significantly increased NO_3-N and NO_2-N contents in lettuce plant. Soil addition of N fertilizers at the rate of 100% from (RD) led to increase the mean values of NO_3-N and NO_2-N, respectively by 231.27 and 1.54, Soil addition of N fertilizers at the rate of 125% from (RD) led to increase the mean values of NO_3-N and NO_2-N, respectively by 246.13 and 1.65. Further addition of N fertilizers at the rate of 150 increased the values of NO_3-N and NO_2-N by 262.47 and 1.77 in dark green leaves (D.G.L).

Table 3: Mean plant height, cm, Fresh & dry weight of lettuce plant and fresh yield and their interaction as affected by mineral fertilization and some foliar addition.

Characterizes / Seasons / Treatments			D.G.L weight $g.plant^{-1}$	L.G.L weight $g.plant^{-1}$	Total fresh Weight $g.plant^{-1}$	Plant height cm	Dry weight $g.plant^{-1}$
NO_4NO_3	100%	0	١١٦.٧	٨٤.٥	٢٠١.٢	٢٧.٣	٤٨.٣
		A.A	١٧٦.٦	١٢٧.٩	٣٠٤.٥	٢.٨	٧٣.٠٨
		Sa	١٣٧.٧	٩٩.٠	٢٣٦.٧	٢٩.٢	٥٩.٢
		B	٢١٦.٧	١٥٦.٩	٣٧٣.٦	٣٦.٢	٩٣.٤
		Mo	٢٦٣.٥	١٩٠.٧	٤٥٤.٢	٤٠.٥	١١٣.٥
	125%	0	١١٠.٠	٧٩.٦	١٨٩.٦	٢٦.٦	٣٩.٨
		A.A	١٦٣.٥	١١٨.٥	٢٨٢.٠	٣١.٦	٥٩.٢
		Sa	١٣٠.١	٩٤.٢	٢٢٤.٣	٢٨.٤	٤٧.١
		B	٢١٠.١	١٥٢.٢	٣٦٢.٣	٣٥.٦	٧٢.٥
		Mo	٢٥٠.١	١٨١.١	٤٣١.٢	٣٩.٤	٨٦.٢
	150%	0	١٠٣.٣	٧٤.٨	١٧٨.١	٢٦.١	٣٢.٧
		A.A	١٥٠.٠	١٠٨.٦	٢٥٨.٦	٣٠.٣	٣٨.٨
		Sa	١٢٣.٤	٨٩.٤	٢١٢.٨	٢٧.٨	٣١.٩
		B	١٩٠.٢	١٣٧.٧	٣٢٧.٩	٣٣.٨	٥٥.٧
		Mo	٢٤٠.١	١٦٦.٧	٤٠٦.٨	٣٧.٤	٧٣.٢
$(NH_4)_2SO_4$	100%	0	١٧٠.٤	٨٧.٤	٢٥٧.٨	٣٢.١	٤٦.٤٠
		A.A	٢٤٣.٣	١٧٦.٢	٤١٩.٥	٣٨.٦	٧٩.٧
		Sa	٢٠٣.٣	١٤٧.٣	٣٥٠.٦	٣٥.٢	٦٦.٦
		B	٢٧٧.١	٢٠٠.٧	٤٧٧.٨	٤١.٦	٩٠.٨
		Mo	٢٩٧.٣	٢١٥.٣	٥١٢.٦	٤٣.٤	١٢٨.٢
	125%	0	١٥٧.٣	١١٣.٩	٢٧١.٢	٣٠.٩	٦٧.٨
		A.A	٢٣٦.٨	١٧١.٥	٤٠٨.٣	٣٨.٣	١٠٢.٠٨
		Sa	١٩٧.٠	١٤٢.٦	٣٣٩.٦	٣٤.٤	٧٨.١١
		B	٢٧٠.٤	١٩٥.٨	٤٦٦.٢	٢٩.٠	١٠٧.٢
		Mo	٢٩١.٥	٢١١.١	٥٠٢.٦	٤٢.٦	١٠٥.٥
	150%	0	١٤٤.٦	١٠٤.٧	٢٤٩.٣	٢٩.٦	٥٢.٤
		A.A	٢٠٨.٩	١٥١.٣	٣٦٠.٢	٣٦.٨	٧٠.٨
		Sa	١٨٤.٨	١٣٣.٨	٣١٨.٦	٣٣.٨	٦٠.٥
		B	٢٥٦.٥	١٣٥.٨	٣٩٢.٣	٣٩.٩	٧٣.٣
		Mo	٢٨٤.٣	٢٠٥.٨	٤٩٠.١	٤٢.٢	٨٨.٢
L.S.D at 0.05 %			٥.٢٨	١٨.٤٤	N.S	N.S	٤.٣٦

Table 4: Nitrate & nitrite content of lettuce plant as affected by mineral fertilization and some micronutrients and antioxidants.

Characterizes	L.G.L		D.G.L	
Seasons / Treatments	NO_3-N	NO_2-N	NO_3-N	NO_2-N
Nitrogen application Form				
NO_4NO_3	288.33 a	1.94 a	123.09 a	1.02 a
$(NH_4)_2SO_4$	204.91 b	1.37 b	79.09 b	0.63 b
L.S.D at 0.05 %	5.17	0.04	3.04	0.02
Nitrogen application Rate				
100%	231.27 c	1.54 c	94.57 c	0.78 c
125%	246.13 b	1.65 b	101.50 b	0.82 b
150%	262.47 a	1.77 a	107.20 a	0.87 a
L.S.D at 0.05 %	3.54	0.02	1.51	0.01
Foliar application treatments				
0	342.22 a	2.36 a	140.22 a	1.09 a
A.A	245.00 c	1.65 c	99.50 c	0.82 c
Sa	297.67 b	2.05 b	120.33 b	0.95 b
B	198.22 d	1.28 d	81.61 d	0.69 d
Mo	150.00 e	0.94 e	63.78 e	0.56 e
L.S.D at 0.05 %	3.35	0.02	1.75	0.01

A.A: ascorbic acid 250ppm **B: borax 50 ppm**
Sa: sodium- salsalate10 ppm **Mo: Na – Molybdate 10 ppm**
D.G.L: dark green leaves **L.G.L: light green leaves**

Soil addition of N fertilizers at the rate of 150% from (RD) led to increase the mean values of NO3-N and NO2-N, respectively by 107.20 and 107.20, in light green leaves (L.G.L).

With the regard to the effect of interaction between the treatments of this investigation; data in Table (5) indicate that, spraying any micronutrients and antioxidants on the leaves of lettuce plant grown under the rates of N fertilization 100,125 or 150 % from the recommended doses significantly decreased the mean values of NO_3-N and NO_2-N concentration than those obtained for the plants treated with the same rates of N only. In this connection; the highest decrease percentages which calculated to be 56.17 and 60.17 %for dark green leaves and 54.5 and 48.6 % for light green leaves respectively were realized for the plants treated with 150% from the (RD) of N coupled with spraying with sodium Molybdate less than the same values for the plants received 150% RD only.

Foliar spraying of sodium Molybdate, in the presence of mineral fertilizers resulted in pronounce decrease in the values of NO_3-N and NO_2-N in lettuce plant due to the role played by micronutrients for increasing the activity of nitrate reductase enzymes.

Data in Table 5 indicate that the interactions of N fertilization forms, levels, foliar spraying of micronutrients and antioxidants had no significant effect on the mean values of nitrate and nitrite contents on fresh weight basis of lettuce plant.

These results are in the harmony with the conclusions reported by Malakouti, *et al*., (1999), Ai, *et al*., (2000), Abdel-Rahman *et al.,* (2001), El-Agrodi *et al*., (2001), Ramadan (2004), Lashin (2006), Rashwan (2006) and

Abd-Allah (2001) who stated that; increasing the rate of N-fertilization gradually and significantly increased NO3-N and NO2-N content in spinach plant. Foliar application of (Fe + Mo) at any level of N-fertilization sharply and high significantly decreased the values of nitrate and nitrite contents than those obtained when the same N- rates were added only.

Table 5: Nitrate & nitrite content of lettuce plant as affected by mineral fertilization and some micronutrients and antioxidants and their interactions.

Characterizes			L.G.L		D.G.L	
Treatments \ Seasons			NO_3-N	NO_2-N	NO_3-N	NO_2-N
NO_4NO_3	100%	0	٣٧٦.٣٣	٢.٥٨	١٦٤.٠٠	١.٢٥
		A.A	٢٧١.٦٧	١.٨٠	١١٥.٠٠	٠.٩٦
		Sa	٣٢٢.٦٧	٢.٢٢	١٣٦.٠٠	١.١١
		B	٢١٧.٦٧	١.٤٣	٩٣.٠٠	٠.٨٤
		Mo	١٦٧.٠٠	١.٠٥	٦٩.٠٠	٠.٧٠
	125%	0	٣٩٣.٦٧	٢.٦٨	١٧٠.٠٠	١.٢٩
		A.A	٢٨٨.٦٧	١.٩٥	١٢٣.٠٠	١.٠٢
		Sa	342.67	٢.٣٥	١٤٨.٦٧	١.١٤
		B	٢٣٧.٣٣	١.٥٥	٩٨.٦٧	٠.٨٩
		Mo	١٨٣.٣٣	١.١٩	٧٧.٦٧	٠.٧٣
	150%	0	٤٠٨.٠٠	٢.٧٧	١٧٥.٠٠	١.٣٢
		A.A	٣٠٣.٠٠	٢.٠٩	١٣٠.٠٠	١.٠٧
		Sa	٣٦٠.٠٠	٢.٤٧	١٥٦.٦٧	١.٢٠
		B	٢٥٥.٠٠	١.٦٤	١٠٣.٦٧	٠.٩٣
		Mo	١٩٨.٠٠	١.٣٢	٨٦.٠٠	٠.٧٩
$(NH_4)_2SO_4$	100%	0	٢٨٢.٦٧	١.٩٨	١٠٥.٠٠	٠.٨٥
		A.A	١٨٤.٠٠	١.٢١	٧٠.٦٧	٠.٥٦
		Sa	٢٤٢.٦٧	١.٦٥	٨٦.٠٠	٠.٧١
		B	١٤٦.٦٧	٠.٩٢	٦٠.٣٣	٠.٤٥
		Mo	١٠١.٣٣	٠.٥٦	٤٦.٦٧	٠.٣٦
	125%	0	٢٨٨.٦٧	٢.٠٣	١١١.٦٧	٠.٩٠
		A.A	٢٠٠.٦٧	١.٣٤	٧٦.٠٠	٠.٦٣
		Sa	٢٥٠.٠٠	١.٧٢	٩٥.٦٧	٠.٧٥
		B	١٥٩.٣٣	١.٠٣	٦٣.٣٣	٠.٤٩
		Mo	١١٧.٠٠	٠.٦٨	٥٠.٣٣	٠.٣٨
	150%	0	٣٠٤.٠٠	٢.١٤	١١٥.٦٧	٠.٩٣
		A.A	٢٢٢.٠٠	١.٥١	٨٢.٣٣	٠.٦٨
		Sa	٢٦٨.٠٠	١.٨٧	٩٩.٠٠	٠.٨١
		B	١٧٣.٣٣	١.١٣	٧٠.٦٧	٠.٥٥
		Mo	١٣٣.٣٣	٠.٨١	٥٣.٠٠	٠.٤٢
L.S.D at 0.05 %			N.S	N.S	N.S	N.S

Conclusion: Under the same condition of this investigation it can be recommended that; soil addition of N fertilizers at the rate of 100% from the recommended doses for lettuce plants coupled with foliar addition of Molybdate-Na is recommended as the best treatment for producing a safe yield of lettuce plants. Meanwhile, the highest yield was obtained from the N recommended doses and spraying Molybdate-Na.

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دور إضافة العناصر الغذائية الصغرى ومضادات الأكسدة فى تحسين النمو والمحصول للخضروات المأكولة طازجة.

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تم تنفيذ تجربة اصص تحت الصوبه الخضراء ، كليه الزراعه ، جامعه المنصوره فى الموسم ٢٠٠٩/٢٠١٠ لدراسة ما يلي:

- تأثير صور مختلفة من النيتروجين (نترات الامونيوم – سلفات الامونيوم) ومعدلات (٤٠ – ٥٠ – ٦٠ كجم نيتروجين / فدان) وايضا تاثير الاضافات الورقيه للبورون والموليبدينم ومضادات الأكسدة على النمو وتركيز النترات فى نبات الخس.

اشتملت التجربه على ٢٤ معامله فى تصميم كامل العشوائيه فى ٣ مكرارت ويشمل كل الاحتمالات الممكنه باستخدام ٤ معاملات من الرش الورقى (حمض الاسكوربيك ، سلسلات الصوديوم ، البورن ، موليبدات الصوديوم) وثلاثه معاملات تسميد نيتروجينى معدنى كنسبه من الموصى به (١٠٠% ، ١٢٥% ، ١٥٠%) كإضافه ارضيه بالاضافه الى معاملات التفاعل بينهما .

ويمكن تلخيص النتائج المتحصل عليها على النحو التالى :

- أثبتت النتائج ان استخدام سماد سلفات الامونيوم كمصدر للتسميد الازوتى ادى الى تحقيق اعلى قيمه لارتفاع النبات فى محصول الخس ويليه سماد نترات الأمونيوم .
- زيادة معدل السماد الازوتى لم يعط أى فروق معنويه فى ارتفاع وطول نبات الخس.
- زياده مستوى التسميد الازوتى حتى 60 كجم نيتروجين للفدان لم يعط أى زياده معنويه فى قيم كل من الوزن الطازج والوزن الجاف لنبات الخس فكانت أعلى قيمه فى الوزن الجاف والطازج ناتجه من التسميد عند المستوى ٤٠كجم نيتروجين للفدان .
- الاضافه الورقيه لمضادات الأكسدة(حمض الاسكوربيك وسلسلات الصوديوم) والعناصر الصغرى (البورون والموليبدنيم) ادى الى حدوث زياده معنويه فى قيم كل من الوزن الطازج و الوزن الجاف مقارنه بعدم الرش.
- حدث زياده معنويه فى تراكم النترات والنيتريت فى الاوراق الخضراء للخس بزياده مستويات التسميد المعدنى . الرش الورقى بالعناصر الصغرى ومضادات الأكسدة فى وجود التسميد المعدنى ادى الى نقص ملحوظ فى قيم كل من النترات والنيتريت فى نبات الخس .

الاستنتاج : تحت نفس ظروف هذه الدراسه نوصى باستخدام التسميد الارضى بالاسمده النيتروجينيه المعدنيه عند مستوى ١٠٠% من الموصى به فى وجود الرش الورقى بموليبدات الصوديوم لتحقيق محصول آمن من الخس.

قام بتحكيم البحث

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