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RESPONSE OF GROWTH AND MINERAL COMPOSITION OF RADISH AND PARSLEY PLANTS TO DIFFERENT N-FORMS, N-LEVELS AND SOME MICRONUTIENTS.

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ABSTRACT

A pot experiment was carried out in the season of 2006 under the green house of El-Mansoura Laboratory for Plant Nutrition, Soil, Water and Environment Institute to study the effect of different N forms (ammonium nitrate, ammonium sulphate and urea) and doses (30, 45 & 60 kg N/fed) as well as the effect of foliar application of Fe, Mo & Mn on growth and mineral composition of radish and parsley plants.

The results revealed that using ammonium nitrate as a source of N fertilizer recorded the highest value of plant height followed by ammonium sulphate and urea. The height of radish and parsley plants was significantly increased as the level of nitrogen fertilizer increased. The fresh and dry weights were significantly increased up to 60 kg N level. Foliar application of Fe, Mn and Mo as solely or in mixture significantly increased the values of fresh and dry weights compared to the control. Increasing the level of N fertilizer from 0 to 60 kg N/fed high significantly increased the concentration of N and K, while P concentration was insignificantly affected. Concentration of N or K was significantly increased due to micronutrients application, while P was insignificantly affected. Micronutrients (Fe, Mo and Mn) were gradually and significantly increased as the level of N fertilizer was increased up to 45 kg level of N fertilization.

Keywords: N-Forms, N-Levels, micronutrients, radish plants, parsley plants.

INTRODUCTION

Nitrogen is essential for plant growth, it is a constituent of all proteins and nucleic acids, some of the plant growth regulators, many vitamins and hence of all protoplasm. As a component of these and many other compounds, nitrogen is involved in most of the biochemical reactions that compose life. Abd-Allah (2001) studied the effect of heavy nitrogen application on yield and chemical composition of some vegetable plants. He concluded that NO_3 will be the only nitrogen source for plants in few days even all the applied nitrogen was NH_4 or amide form.

Guo *et al*. (2007) suggested that ammonium nutrition has a negative effect on plant growth due to the adverse effects of NH_4 nutrition on photosynthesis and photorespiration. They also added that, NO3 and NH4 nutrition may use different pathways for NADPH consumption, which leads to differences in photosynthesis and photorespiration.

Many investigators studied the effect of nitrogen levels on plant growth of some leafy vegetable plants .They mentioned that fresh weight and total yield of radish, parsley and other plants were increased by increasing the rate of N fertilizer due to increases in plant height, number of leaves and diameter of the main shoot, (Thapa *et al*. 2003; Pervez *et al*. 2004; Chenard *et al*. 2005)

Talaat (1995) pointed out that increasing the level of N fertilizer to radish plant resulted in a significant increase in plant height, fresh and dry weights. Such effect might be due to the role of nitrogen in both cell division and cell expansion through its effect on DNA synthesis.

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 growh, 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).

Solntera (1976) indicated that Mo enhanced utilization of mineral nutrients from the soil. Iron and manganese increased growth and yield of many plants and also enhanced more accumulation of N,P,K,Fe and Mn (El-Shewy, 1981; Talaat, 1995; Abd Allah, 2001) .In this respect, Mahmoud and Agwah (1993) reported that spraying lettuce plants with Fe at 100 ppm significantly increased leaves content of N, P and K as compared with control treatment. Reddy and Malewar (1994) revealed that an addition of Fe (from 0 to 50 ppm) to soil increased the P content up to 40 ppm. They also found the total Fe content was higher in spinach when grown in soil given 50 ppm Fe.

MATERIALS AND METHODS

A Pot experiment was carried out during the season of 2006 under the green house of El-Mansoura Laboratory for Plant Nutrition of Soil, Water and Environment Institute; Dakahlya Governorate to estimate the effect of N fertilization (levels and forms) as well as foliar application of some micronutrients on growth and chemical compositions of radish and parsley plants.

Sixty treatments were arranged in split split block design, which were the simple possible combination between; three forms of N fertilizers (ammonium nitrate 33.5%N, ammonium sulfate 20.5%N and urea 46%N) were randomly located in the main plot, 4 levels of N fertilization (0, 30, 45 and 60 kg N/fed), were devoted in sub-plot and 5 treatments foliar application of micronutrients were arranged in sub-sub plot as follow:

1- Tap water as a control treatment.
2- Fe-EDTA (13.5% Fe) at the rate of 300 ppm.
3- Mn-EDTA (13% Mn) at the rate of 100 ppm.
4- Mo as sodium molybdate (46% Mo) at the rate of 50 ppm.
5- Mixture of micronutrients (iron, manganese, molybdenum) at the same used rates.

The first addition of N as well as micronutrients was done after 21 days from sowing date and the second one at 15 days later. For each plant; 180 pots (30 cm in diameter and 40 cm depth) were used. Each pot was filled with 15 kg air dry soil taken from the surface layer of a farm near El-Mansoura city and analyzed for some physico-chemical properties as shown in Table (1).

Table 1. Physico-chemical properties of the used soil.

Physical analysis							
Coarse sand %	**Fine sand %**	**Silt %**	**Clay %**	**Texture class**	**Organic Matter %**	**$CaCO_3$ %**	**Saturation Percentage**
1.85	18.93	25.13	54.09	Clayey	2.13	2.85	83
Chemical analysis							
Available nutrients ppm						EC* dS m^{-1}	pH**
N	P	K	Fe***	Mn***	Mo***		
68.5	5.1	425	13.5	8.3	0.73	0.37	7.6

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

Twenty seeds for each radish (*Raphanus sativus*, L.) and parsley (*Petroselinum crispum*) were sown on 26 and 28 October, respectively. After 20 days from sowing, seedlings were thinned to the most five uniform ones per pot. Soil moisture was kept at 60% of water holding capacity till the end of the growing season. All other practical cultural processes were carried out as recommended by the Ministry of Agriculture.

At marketing stage; i.e. 55 days from sowing, three plants (foliage) were randomly taken from each pot. Plant height and fresh weight were recorded. Leaf samples were washed 3 times with 0.05 HCl solution followed by washing 3 times with redistilled water to get red of iron, manganese and molybdenum residues, then oven dried at 70oC till constant weight. The dry matter was calculated and expressed as g/plant and thoroughly ground for chemical analysis.

Mechanical analysis of the used soil was determined following the international pipette method (Kilmer and Alexander, 1949).

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 *et al* (1961).

The oven dry materials of plant samples were ground and wet digested as described by Peterburgski (1968). The total N, P, K, Fe, Mn and Mo were determined using the techniques described by Pregle (1945) and Chapman *et al* (1961).

All the obtained data were subjected to statistical analysis according to Gomez and Gomez (1984). Means of treatments were compared using new least significant differences (NLSD) as described by Waller and Duncan (1969).

RESULTS AND DISCUSSION

Vegetative growth parameters:

Plant height (cm/plant):

The statistical analysis of the data presented in Table 2a indicates that height of radish and parsley plants was significantly affected by N fertilization (forms and levels) as well as foliar application with

micronutrients. Data also illustrate that the height of both plants was significantly increased by using ammonium nitrate and by increasing of the level of N fertilization. Foliar application with the mixture of micronutrients studied was superior for increasing the height of radish and parsley plants followed by single application of iron, manganese, molybdenum and finally the control treatment.

With respect to the interactive effect among N forms, N levels and foliar application of micronutrients, data indicate that foliar application of iron, manganese and molybdenum as a mixture under the highest level of ammonium nitrate was superior for increasing the height of radish and parsley plants compared to the control treatment. On the other hand, using iron solely was the most effective than the other micronutrients used solely under any level or form of N fertilization.

Table 2. Effect of different sources and levels of N fertilization, micronutrients and their interactions on height (cm) of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	22.75	22.58	22.65	20.05	22.82	23.75	24.03	20.94	23.55	23.09	21.83	23.89
parsley	19.14	18.98	18.85	15.60	19.20	20.40	20.8	16.90	19.98	19.39	17.90	20.78

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	19.4	14.9	20.3	16.2	20.0	15.6	19.6	15.1	20.7	16.8
	30	21.2	17.2	23.8	20.1	23.4	19.9	22.3	18.7	24.1	21.0
	45	21.6	17.8	25.1	21.8	24.0	21.3	22.7	18.7	25.5	22.8
	60	22.0	18.4	25.2	22.5	24.8	21.5	23.0	19.2	25.7	23.3
AS	0	19.5	14.5	20.4	15.9	20.0	15.4	19.7	14.9	20.6	16.4
	30	20.8	17.4	23.5	19.8	23.2	19.4	22.1	18.7	24.0	20.4
	45	21.3	17.6	25.0	21.8	24.2	21.0	22.4	18.8	25.3	23.0
	60	21.8	18.1	25.1	22.2	24.6	21.5	22.8	19.3	25.4	23.4
U	0	19.5	14.5	20.4	16.3	20.1	15.6	19.7	14.8	20.8	16.6
	30	21.0	17.0	23.6	19.7	23.2	19.3	22.2	18.4	23.9	20.2
	45	21.4	17.6	25.0	21.6	24.4	20.7	22.5	18.8	25.3	22.5
	60	21.8	17.8	25.2	22.0	24.7	21.4	22.9	19.3	25.4	22.8

Statistical Analysis																
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		**	**	**	**	**	*	**	**	ns	ns	**	**	**	*
LSD	5%	0.01	0.09	0.01	0.09	0.02	0.15	0.01	0.09	--	--	0.02	0.19	0.04	0.34
	1%	0.02	0.16	0.02	0.12	0.03	0.21	0.02	0.11	--	--	0.03	0.26	0.05	0.45

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

It can be concluded that, the effect of nitrogen fertilization on plant height might be due to the role played by nitrogen in both cell division and cell expansion through its effect on the biosynthesis of some plant hormones. In addition, the increases in the height of radish and parsley plants due to foliar application of micronutrients may be attributed to the role played by these elements on plant bioactivities. These results are on line with those obtained by Bhole *et al.* (1998), Naguib *et al.* (2003) and Pervez *et al.* (2004), working on radish and parsley plants.

Fresh and dry weights (g/plant):

Data of Table 3 reveal that there were no significant differences between the mean values either for fresh or dry weight of radish and parsley plants as affected by any form of N fertilizers used.

However, data indicate that increasing the level of N fertilization significantly increased the fresh and dry weights of radish and parsley plants. Comparing with the control treatment, the percentages of increase in fresh weight of radish plant were 16.3, 27.4 and 30.2% and for parsley plant were, 44.2, 64.9 and 71.0% for the treatments of 30, 45, and 60 kg N/fed, respectively. The same trend was realized for the dry weight of both plants.

It is clear from the data presented in Table ٣ that foliar application of the mixture of micronutrients recorded the highest values of fresh weight followed by iron, manganese, molybdenum and finally the control treatment. The differences between these values were significant. Such effect was realized for the values of dry weight for both plants (Table 4).

Concerning the interactive effect among N forms, N levels and micronutrients, results show that foliar application of Fe, Mn, Mo solely or in mixture at any level of N fertilization had a high significant increase for the values of fresh and dry weights of radish and parsley plants. This trend was realized for any form of N fertilizers.

It can be concluded that fresh and dry weights of radish and parsley plants were increased by increasing the rate of N fertilization, this may be due to the beneficial effect of nitrogen on stimulating the merestimatic activity for producing more tissues and organs since nitrogen is a constituent of proteins, nucleic acids and many important substances of plant cell. In this connection, Talaat (1995) reported that the increase in fresh weight of the shoot of radish resulting from increasing N application is quite expected since it is well established that decreasing the C/N ratio within the plant usually favours vegetative growth.

The favourable role of iron, molybdenum and manganese on stimulating vegetative growth of radish and parsley plants may be referred to the role of these nutrients on plant bioactivities through out its effect on enzymatic systems responsible for biosynthesis of amino acids, proteins chlorophyll and through improvement of the nutrient status of the plants, (Chenard *et al*.,2005 and Mohamed, 2006). In this respect, Mengel and Kirkby (1978) reported that micronutrients are essential elements for plant life, particularly under limiting conditions. They act as plant growth hormones and play an important role in the production and function of several enzyme systems in plants.

Mineral concentration

Macronutrient concentration (N, P and K):

The statistical analysis of the data presented in Tables 5 to 7 show that the different sources of N fertilizer had no significant effect on the concentration of N, P and K in radish and parsley plants. Increasing the level of N fertilization from 0 to 60 kg N/fed high significantly increased the concentration of N and K comparing with control treatment. On the other hand, P concentration in the leaves of the two plants was not significantly affected by the levels of N fertilization (Table 6).In this respect, Gulser (2005)

investigated the effects of ammonium sulphate (AS) and urea on nutrient contents in spinach plant. He indicated that increments in nitrogen doses of AS and urea from 0 to 150 kg N/ha significantly increased total N contents but usually decreased P, Zn and Mn contents. The decrease in micronutrient contents in spinach at the higher nitrogen doses might be due to the dilution effect by increasing the plant biomass.

Table 3. Effect of different sources and levels of N fertilization, micronutrients and their interaction on fresh weight (g/plant) of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
Radish	25.69	25.85	26.01	21.82	25.38	27.80	28.40	23.02	26.75	26.50	24.50	28.49
Parsley	6.98	6.87	6.92	4.77	6.88	7.87	8.16	5.50	7.70	7.12	6.07	8.23

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	20.80	4.32	22.20	5.04	21.70	4.64	21.30	4.40	22.27	5.20
	30	22.40	5.60	19.22	7.52	26.70	7.36	25.10	6.40	28.20	7.92
	45	23.99	5.92	30.03	9.36	28.70	8.16	25.80	6.64	32.03	10.00
	60	24.60	6.32	30.99	9.36	29.20	8.48	26.20	6.80	32.40	10.24
AS	0	20.99	4.32	22.30	4.96	21.80	4.64	21.40	4.40	22.80	5.20
	30	23.10	5.60	27.00	7.36	26.50	7.20	24.80	6.32	27.70	7.68
	45	23.60	6.08	29.40	8.56	28.40	8.00	25.30	6.56	31.10	9.76
	60	24.20	6.08	30.30	9.36	28.80	8.56	25.99	6.80	31.60	9.92
U	0	21.10	4.40	22.40	5.12	21.99	4.88	21.50	4.72	22.70	5.36
	30	23.30	5.52	27.20	7.52	26.60	6.96	24.93	6.32	28.00	7.92
	45	23.70	5.84	29.50	8.88	28.60	8.08	25.60	6.64	31.30	9.60
	60	24.40	6.00	30.50	9.36	29.03	8.48	26.03	6.80	31.80	9.92

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	ns	ns	ns	ns	**	**	**	**
LSD	5%	--	--	0.82	0.06	1.42	0.09	--	--	--	--	1.73	0.16	2.99	0.27
	1%	--	--	1.13	0.07	1.95	0.13	--	--	--	--	2.28	0.21	3.96	0.36

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Table 4. Effect of different sources and levels of N fertilization, micronutrients and their interaction on dry weight (g/plant) of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	2.15	2.12	2.13	1.82	2.14	2.27	2.31	1.92	2.24	2.17	2.02	2.32
parsley	2.13	2.01	1.98	1.53	2.09	2.24	2.31	1.64	2.23	2.07	1.85	2.43

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	1.74	1.36	1.85	1.52	1.80	1.52	1.77	1.44	1.89	1.76
	30	1.96	1.76	2.24	2.40	2.20	2.40	2.08	2.16	2.29	2.48
	45	2.00	1.76	2.42	2.64	2.33	2.40	2.12	2.08	2.59	2.96
	60	2.04	1.84	2.48	2.72	2.37	2.40	2.16	2.16	2.63	2.88
AS	0	1.75	1.44	1.86	1.60	1.81	1.52	1.78	1.44	1.91	1.76
	30	1.93	1.76	2.21	2.16	2.17	2.00	2.05	2.00	2.26	2.32
	45	1.97	1.68	2.39	2.48	2.31	2.32	2.09	1.84	2.50	2.72
	60	2.01	1.60	2.44	2.56	2.34	2.32	2.13	2.00	2.54	2.72
U	0	1.75	1.44	1.87	1.52	1.83	1.52	1.79	1.36	1.92	1.76
	30	1.94	1.60	2.22	2.08	2.19	1.92	2.07	1.92	2.27	2.32
	45	1.98	1.68	2.40	2.40	2.32	2.16	2.10	1.84	2.52	2.64
	60	2.02	1.76	2.45	2.64	2.35	2.40	2.14	1.92	2.56	2.80

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	Par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	ns	ns	ns	ns	**	**	**	**
LSD	5%	--	--	0.01	0.07	0.01	0.01	--	--	--	--	0.01	0.01	0.02	0.02
	1%	--	--	0.02	0.09	0.02	0.02	--	--	--	--	0.02	0.02	0.03	0.03

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Data also record that using foliar application of micronutrients as a mixture was superior for increasing the N and K concentrations of radish and parsley plants followed by iron, manganese and molybdenum. The percentages of increase in N concentration for radish plant were 9.9, 7.5, 3.1 and 12.7 (Table 5) and those of K concentration were 15.1, 13.0, 5.0 and 18.3 (Table 7) for the treatments of Fe, Mn, Mo and Mix., respectively compared to the control. The same trend was realized for parsley plant. Phosphorus concentration was insignificantly affected for both plants as a result of foliar application with micronutrients either in solely way or as a mixture.

Tables 5b-7b reveal that the interactive effect among N forms, N levels and foliar application of micronutrients high significantly affected the concentration of N of parsley as well as K and P of both plants. Foliar application of iron, manganese and molybdenum as a mixture at the highest level of ammonium nitrate, was superior for increasing N, P and K concentrations. Using Fe solely as a foliar application was more effective than the other micronutrients used under any level and form of N fertilization.

From these results, it can be concluded that, the increase in N concentration by increasing the level of N fertilization may be due to the role of nitrogen in activating the physiological functions of plant cells and in turn the uptake of these nutrients from the soil solution. The increase in K concentration with increasing N level is explained by Tisdale and Nelson (1975) who reported that, "Potassium in soils is taken up by the plant as an ion (K^+), and is thus important to the uptake of the nitrate (NO^-_3) in maintaining ionic balance. The influence of K^+ on nitrate levels is therefore catalytic. Potassium is essential in protein synthesis".

Foliar application of Fe, Mo and Mn led to an increase in the activity of nitrate reductase enzymes, consequently more reduction of NO_3-N and NO_2-N were happened resulted in producing nitrogenous compounds like protein. The increases in the concentration of P and K due to the foliar application of Fe, Mn and Mo may be attributed to the stimulating effect of these micronutrients on plant bioactivities which resulted in more accumulation of macronutrients in plant leaves. In this respect, Kheir *et al*. (1991) reported that application of Mo alone or with Fe tended to increase P and K content over the control treatment. Also, Solntera (1976) indicated that Mo enhanced utilization of mineral nutrients from the soil.

The results are satisfactory consistent with those obtained by El-Mansi *et al*. (2004); El-Kassas (2005); Ahmed and Morsy (2005) and El-Mahdy (2007).

Micronutrient concentration (Fe, Mo and Mn ppm):

Data in Tables 8a-1،a indicate that using any form of N fertilizer had no significant effect on the mean values of Fe, Mo and Mn. Values of these nutrients gradually and significantly increased as the level of N fertilization was increased up to 45 kg N/fed. Increasing the level of N up to 60 kg significantly decreased the values of Fe (the reduction in parsley was insignificant), Mo and Mn in the two plants; radish and persley.

Data also show that foliar application of Fe, Mo, Mn solely and their mixture resulted in a significant effect on the concentration of Fe, Mo and Mn in radish and parsley plants.

Table 5. Effect of different sources and levels of N fertilization, micronutrients and their interaction on N% of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	3.12	3.10	3.11	2.84	3.11	3.23	3.27	2.92	3.21	3.14	3.01	3.29
parsley	3.39	3.31	3.38	3.05	3.37	3.45	3.56	3.15	3.49	3.42	3.25	3.49

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	2.77	2.97	2.86	3.09	2.82	3.04	2.79	2.99	2.90	3.12
	30	2.95	3.18	3.21	3.49	3.17	3.45	3.05	3.30	3.25	3.54
	45	2.97	3.22	3.38	3.69	3.28	3.59	3.10	3.35	3.53	3.85
	60	3.01	3.28	3.43	3.75	3.32	3.64	3.13	3.39	3.56	3.88
AS	0	2.78	2.99	2.88	3.09	2.83	3.05	2.80	3.01	2.92	3.13
	30	2.92	3.15	3.18	3.46	3.14	3.41	3.02	3.27	3.22	3.51
	45	2.96	3.19	3.34	3.66	3.26	3.56	3.06	3.32	3.45	2.77
	60	2.98	3.23	3.39	3.71	3.30	3.61	3.12	3.37	3.49	3.80
U	0	2.76	2.97	2.88	3.10	2.84	3.07	2.81	3.02	2.92	3.13
	30	2.94	3.16	3.19	3.47	3.15	3.43	3.04	3.29	3.23	3.52
	45	2.97	3.20	3.36	3.68	3.28	3.57	3.08	3.33	3.47	3.79
	60	2.99	3.24	3.41	3.73	3.31	3.63	3.13	3.38	3.51	3.82

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	ns	ns	ns	ns	**	**	ns	**
LSD	5%	--	--	0.06	0.06	0.01	0.01	--	--	--	--	0.01	0.01	--	0.02
	1%	--	--	0.09	0.09	0.02	0.02	--	--	--	--	0.02	0.02	--	0.03

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Table 6. Effect of different sources and levels of N fertilization, micronutrients and their interaction on P% of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	0.46	0.45	0.46	0.40	0.46	0.49	0.49	0.41	0.48	0.46	0.44	0.49
parsley	0.54	0.53	0.54	0.43	0.54	0.59	0.59	0.47	0.58	0.54	0.50	0.60

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	Parsley
AN	0	0.38	0.40	0.40	0.44	0.39	0.42	0.39	0.41	0.41	0.46
	30	0.42	0.48	0.48	0.58	0.47	0.56	0.44	0.52	0.49	0.60
	45	0.43	0.49	0.51	0.65	0.49	0.61	0.45	0.54	0.54	0.69
	60	0.44	0.51	0.53	0.66	0.50	0.63	0.46	0.55	0.55	0.69
AS	0	0.38	0.41	0.41	0.45	0.39	0.42	0.39	0.41	0.41	0.46
	30	0.42	0.47	0.47	0.57	0.46	0.56	0.44	0.51	0.48	0.59
	45	0.42	0.49	0.51	0.63	0.49	0.60	0.45	0.53	0.53	0.64
	60	0.43	0.50	0.52	0.65	0.50	0.47	0.46	0.54	0.54	0.67
U	0	0.38	0.41	0.41	0.45	0.40	0.44	0.39	0.42	0.41	0.46
	30	0.42	0.48	0.47	0.58	0.47	0.56	0.44	0.52	0.48	0.59
	45	0.43	0.49	0.51	0.64	0.49	0.61	0.49	0.53	0.53	0.67
	60	0.43	0.50	0.52	0.65	0.50	0.62	0.46	0.55	0.54	0.68

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	**	ns	**	**
LSD	5%	--	--	--	--	--	--	--	--	--	--	0.002	--	0.01	0.06
	1%	--	--	--	--	--	--	--	--	--	--	0.001	--	0.02	0.08

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Table 7. Effect of different sources and levels of N fertilization, micronutrients and their interaction on K% of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	3.75	3.69	3.74	3.21	3.74	3.94	4.02	3.38	3.89	3.82	3.55	4.00
parsley	4.94	4.90	4.93	4.30	4.93	5.19	5.28	4.51	5.13	4.98	4.69	5.30

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	Parsley
AN	0	3.09	4.13	3.25	4.35	3.19	4.27	3.13	4.19	3.32	4.43
	30	3.43	4.59	3.93	5.13	3.85	5.05	3.64	4.80	3.99	5.21
	45	3.49	4.65	4.24	5.50	4.08	5.28	3.71	4.87	4.43	5.85
	60	3.57	4.73	4.31	5.62	4.16	5.39	3.78	4.96	4.45	5.90
AS	0	3.10	4.15	3.28	4.39	3.20	4.30	3.14	4.22	3.35	4.46
	30	3.38	4.52	3.86	5.07	3.80	4.98	3.60	4.75	3.94	5.14
	45	3.46	4.62	3.85	5.44	4.02	5.23	3.66	4.83	4.34	5.66
	60	3.51	4.67	4.26	5.54	4.33	5.32	3.74	4.90	4.06	5.75
U	0	3.08	4.16	3.30	4.41	3.23	4.32	3.16	4.25	3.37	4.50
	30	3.40	4.56	3.89	5.10	3.83	5.01	3.62	4.78	3.96	5.18
	45	3.47	4.63	4.21	5.46	4.04	5.26	3.69	4.85	4.37	5.69
	60	3.54	4.69	4.29	5.58	4.13	5.35	3.77	4.92	4.41	5.80

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	*	**	ns	ns	ns	ns	**	**	**	**
LSD	5%	--	--	0.03	0.04	0.06	0.07	--	--	--	--	0.12	0.07	0.20	0.01
	1%	--	--	0.04	0.06	--	0.10	--	--	--	--	0.16	0.09	0.27	0.02

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

With respect to the interaction among N forms, N levels and foliar application of micronutrients, data of Tables 8b-1،b indicate that the differences between the values for each of Fe, Mo and Mn gradually and significantly increased as the level of N addition was increased up to the rate of 45 kg N/fed. It can be concluded that, N fertilization at the higher rates (60 kg/fed) resulted in a state of imbalance between nitrogen and micronutrients (Fe, Mo and Mn) in the leaves of radish and parsley plants leading to more accumulation of nitrate in the leaves. This can be corrected by foliar spraying of Fe, Mo and Mn which led to an equilibrium between these nutrients within the plant to give an excellent conditions for NO_3 reduction and to keep the NO_3 accumulation at the lowest value.

Generally, it can be stated that the primitive effects of micronutrients on plant growth and plant chemical composition may be due to their effects on many metabolic and physiological processes and consequently mineral uptake.

The above results are generally in a good agreement with many such finding as those of Abd Allah (2001); El-Sawah and Gadallah (2004) and Kaiser *et al*. (2005).

Table 8. Effect of different sources and levels of N fertilization, micronutrients and their interaction on Fe (ppm) of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	18.3	18.7	17.9	14.0	18.3	20.9	19.9	13.7	25.7	13.3	16.9	21.7
parsley	148.1	149.6	144.0	125.8	145.3	160.5	157.2	123.1	183.9	120.6	144.4	164.0

b)Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	Parsley
AN	0	9.74	98.00	21.42	168.00	10.64	107.00	11.41	111.00	17.39	146.00
	30	12.44	116.00	25.62	185.00	13.32	120.00	18.09	151.00	22.39	173.00
	45	16.69	141.00	29.59	194.00	14.95	130.00	18.79	155.00	24.09	180.00
	60	15.72	135.00	26.49	190.00	14.24	125.00	19.41	160.00	23.14	176.00
AS	0	10.14	101.00	20.84	166.00	10.91	108.00	11.67	112.00	17.71	147.00
	30	12.79	117.00	26.11	187.00	13.61	122.00	18.24	153.00	22.04	172.00
	45	16.99	142.00	30.74	198.00	15.19	133.00	19.09	158.00	24.81	182.00
	60	15.96	137.00	28.09	192.00	14.84	127.00	19.65	161.00	23.69	177.00
U	0	9.84	102.00	19.72	163.00	10.49	105.00	11.14	109.00	17.11	144.00
	30	12.09	114.00	25.15	183.00	13.17	119.00	17.94	150.00	21.65	118.00
	45	16.34	140.00	28.71	193.00	14.72	128.00	18.51	154.00	23.94	179.00
	60	15.39	134.00	26.32	188.00	13.93	123.00	19.19	159.00	22.89	174.00

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	**	**	**	**	**	**	**	**
LSD	5%	--	--	0.10	5.05	0.18	8.75	0.11	5.32	0.19	9.22	0.22	10.64	0.38	18.43
	1%	--	--	0.14	6.92	0.25	11.98	0.15	7.03	0.25	12.18	0.29	14.07	0.50	24.36

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Table 9. Effect of different sources and levels of N fertilization, micronutrients and their interaction on Mo (ppm) of radish and parsley plants.

a) Single effect:

Plant	$\bar{X}$ (F)			$\bar{X}$ (L)				$\bar{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	1.04	0.99	0.99	0.62	1.04	1.24	1.12	0.58	0.93	0.54	1.60	1.38
parsley	1.33	1.32	1.28	0.88	1.31	1.56	1.48	0.85	1.18	0.79	2.07	1.66

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	0.18	0.44	0.37	0.66	0.26	0.53	1.37	1.56	1.02	1.28
	30	0.44	0.71	1.07	1.32	0.54	0.80	1.73	2.13	1.44	1.71
	45	0.88	1.17	1.16	1.39	0.72	0.96	1.91	2.40	1.58	1.95
	60	0.79	1.07	1.22	1.46	0.65	0.88	1.86	2.30	1.54	1.82
AS	0	0.21	0.46	0.34	0.63	0.28	0.55	1.34	1.57	0.98	1.25
	30	0.47	0.74	1.06	1.29	0.55	0.82	1.68	2.08	1.59	1.67
	45	0.91	1.18	1.14	1.35	0.74	0.98	1.96	2.46	1.56	1.97
	60	0.83	1.10	1.20	1.44	0.67	0.90	0.81	2.22	1.51	1.78
U	0	0.20	0.47	0.32	0.60	0.24	0.51	1.25	1.50	0.97	1.22
	30	0.40	0.69	1.04	1.27	0.52	0.76	1.64	2.04	1.39	1.64
	45	0.86	1.14	1.10	1.34	0.69	0.94	1.88	2.35	1.55	1.87
	60	0.77	1.04	1.17	1.41	0.61	0.85	1.77	2.18	1.47	1.75

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	**	**	**	**	**	**	**	**
LSD	5%	--	--	0.01	0.03	0.08	0.05	0.05	0.03	0.08	0.05	0.10	0.06	0.17	0.01
	1%	--	--	0.02	0.04	0.11	0.06	0.06	0.04	0.11	0.06	0.13	0.07	0.22	0.02

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

Table 10. Effect of different sources and levels of N fertilization, micronutrients and their interaction on Mn (ppm) of radish and parsley plants.

a) Single effect:

Plant	$\overline{X}$ (F)			$\overline{X}$ (L)				$\overline{X}$ (M)				
	AN	AS	U	0	30	45	60	0	Fe	Mn	Mo	Mix
radish	3.84	3.89	3.80	3.57	3.73	4.12	3.95	2.33	3.03	5.55	3.78	4.52
parsley	8.60	8.60	8.47	7.87	8.31	9.11	8.95	4.75	6.58	12.52	8.44	10.50

b) Interactive effect:

Treatments		Micronutrients (ppm)									
N-forms	N levels (Kg/fed)	0		Fe		Mn		Mo		Mix	
		radish	parsley	radish	parsley	radish	parsley	radish	parsley	radish	parsley
AN	0	2.12	4.24	2.78	5.84	5.04	11.52	3.60	7.91	4.30	9.80
	30	2.24	4.55	2.97	6.34	5.34	12.23	3.71	8.17	4.57	10.31
	45	2.41	4.91	3.15	6.83	6.11	13.40	4.15	9.32	4.94	11.40
	60	2.59	5.28	3.40	7.40	5.64	12.84	3.95	8.80	3.79	10.85
AS	0	2.09	4.28	2.71	5.62	5.19	11.81	3.52	7.78	4.38	9.94
	30	2.30	4.68	3.03	6.50	5.41	12.43	3.65	8.08	4.51	10.20
	45	2.35	4.75	3.09	6.71	6.21	13.64	4.07	9.18	4.88	11.38
	60	2.65	5.39	3.33	7.45	5.84	12.92	3.89	8.61	4.71	10.74
U	0	2.08	4.29	2.84	5.97	5.12	11.69	3.47	7.62	4.22	9.69
	30	2.18	4.41	2.90	6.19	5.25	12.04	3.46	8.34	4.45	10.11
	45	2.47	5.04	3.21	6.92	5.95	13.09	4.01	8.95	4.87	11.09
	60	2.52	5.17	2.92	7.14	5.52	12.67	3.84	8.48	4.65	10.50

Statistical Analysis															
Treatments		F		L		M		FxL		FxM		LxM		FxLxM	
F-test		rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.	rad.	par.
		ns	ns	**	**	**	**	**	**	**	**	**	**	**	**
LSD	5%	--	--	0.03	0.03	0.07	0.06	0.04	0.03	0.08	0.06	0.09	0.06	0.17	0.11
	1%	--	--	0.05	0.05	0.09	0.08	0.06	0.04	0.11	0.08	0.13	0.08	0.23	0.15

AN = Ammonium nitrate AS = Ammonium sulfate U = urea
(F) = N forms (L) = N levels (kg/fed) (M) = Micronutrients (ppm)

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استجابه النمو والتركيب الكيميائى لنباتى الفجل والبقدونس لصور ومعدلات مختلفه من التسميد النيتروجينى وبعض العناصر الصغرى.

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اجريت تجربه اصص فى موسم ٢٠٠٦ فى الصوبه الزراعيه بمعمل بحوث تغذيه النبات بالمنصوره – محافظه الدقهليه ، التابع لمعهد بحوث الاراضى والمياه والبيئه لدراسه ما ياتى:

- تاثير صور مختلفه من النيتروجين (نترات الامونيوم – سلفات الامونيوم واليوريا) ومعدلات (٣٠ – ٤٥ – ٦٠ كجم نو / فدان) وايضا تاثير الاضافات الورقيه للحديد والموليبدينم و المنجنيز على النمو وتركيز العناصر الصغرى فى نباتى الفجل والبقدونس.
- أثبتت النتائج ان استخدام سماد نترات الامونيوم كمصدر للتسميد الازوتى ادى الى تحقيق اعلى قيمه لارتفاع النبات ويليه سماد سلفات الامونيوم ثم اليوريا على التوالى.
- حدثت زياده معنويه فى ارتفاع النبات كلما زاد معدل اضافه السماد الازوتى وذلك بالنسبه لكل من الفجل والبقدونس.
- فى كلا المحصولين ادى زياده مستوى التسميد الازوتى حتى ٦٠ كجم نيتروجين للفدان الى حدوث زياده معنويه فى قيم كل من الوزن الطازج والوزن الجاف.
- الاضافه الورقيه للعناصر الصغرى (الحديد والمنجنيز والموليبدنيم) سواء فى صوره فرديه اوكمخلوط من العناصر ادى الى حدوث زياده معنويه فى قيم كل من الوزن الطازج و الوزن الجاف مقارنه بعدم الرش.
- زياده معدل التسميد الازوتى من ٠ الى ٦٠ كجم نو/فدان ادى الى حدوث زياده معنويه فى تركيز كل من النيتروجين والبوتاسيوم ولم تحدث اى زياده معنويه بالنسبه لتركيز الفوسفور مقارنه بمعامله عدم الرش.
- الاضافات الورقيه للعناصر الصغرى ادى لحدوث زياده معنويه فى تركيز النيتروجين والبوتاسيوم ولم تحدث اى زياده معنويه بالنسبه لتركيز الفوسفور لنباتى الفجل والبقدونس.
- زياده مستويات التسميد الازوتى حتى ٤٥ كجم نيتروجين/ الفدان ادى الى زياده تركيز العناصر الصغرى (حديد ومنجنيز وموليبدنيم).

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