ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 44(3): 1181-1206, (2006).

RESPONSE OF GROWTH AND PRODUCTIVITY OF LEEK (*Allium porrum* L.) TO NITROGEN AND POTASSIUM FERTILIZATION
BY

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ABSTRACT

The effect of nitrogen and potassium fertilizer on leek was evaluated through two field experiments during the two the successive growing seasons of 2003/2004 and 2004/2005 at a private farm, Tamiya, Fayoum Governorate, Egypt. To verify this objective, leek " cv. Cleopatra" was grown and treated with nitrogen fertilizer at rates of 100, 150, 200 and 250 Kg N fed.$^{-1}$ as soil application of ammonium nitrate (33.5%N) or urea (46%N). Potassium sulphate (48% K_2O) was used as the respective K source. Nitrogen treatments were applied in 4 equal applications; 25% of the quantity was spread on the rows before transplanting and the rest amount was added at 30, 50 and 70 days from transplanting. Treatments comprised 2 levels of K; 48 and 96 Kg K_2O fed.$^{-1}$ at two equal doses; 50 and 70 days from transplanting. Data of growth characters; plant height, No. of leaves plant^{-1}, fresh and dry weight of leaves plant^{-1} fresh and dry weight of bulb plant $^{-1}$ and total fresh and dry weight plant^{-1} were estimated. Also, total yield (ton fed.$^{-1}$), and some chemical constituents; leaf pigments; total chlorophyll and carotenoids, nitrogen, phosphorus, potassium, nitrite and nitrate concentration of leek were estimated.

The obtained results showed the following trends:

- Growth characters were affected by the application of nitrogen and potassium fertilization in both seasons. In this respect, urea as a N- source was superior over ammonium nitrate in both seasons. At any N-source, the growth characters were significantly increased by increasing the level of N fertilizer in both seasons. The application of K fertilizer at the high rate (96 kg K_2O fed.$^{-1}$) exhibited a marked and significant increase in fresh weight of leaves plant^{-1}, fresh and dry weight bulb^{-1} as well as fresh and dry weights plant^{-1} in both seasons. However, plant height in the first season and fresh and dry weights of leaves plant^{-1} in the second season were insignificant. The interaction of N-source by N-level, in general, showed insignificant effect on most growth studied characters in both seasons.
- The produced leek yield from urea fertilization scored higher values than those produced from ammonium nitrate treatments, although the difference did not reach the level of significance. Among treatments with every increment of N level, potassium fertilization had a significant increase on yield of leek and the higher yield values were recorded with the higher K

level (96 kg K_2O fed.$^{-1}$) in both seasons. No significant effects were detected with the interactions between the three factors on yield of leek in both seasons.

- The main effects of N-source indicated that, the plants treated with urea-N gave the lowest values for NO_2 and NO_3 concentration while, NO_3-treated ones gave the highest values in leaves and bulbs in both seasons. As for N-level effects, N application increased both NO_2 and NO_3 concentration in leaves and bulbs of leek in both seasons. However, NO_2 and NO_3 decreased with increasing K level in both leaves and bulbs. The increase of K rate at any N level either as urea or NO_3 source resulted in a reduction in NO_2 and NO_3 concentrations in leaves and bulbs in both seasons.

Finally, The results of this study showed that the application of urea-N at the rate of 250 Kg fed.$^{-1}$ and K at the rate of 96 Kg fed.$^{-1}$ was found to be the best dose of fertilizer and can be recommended for the highest growth, yield and quality of leek.

Key words: leek, nitrogen, phosphorus, fertilization, growth, yield

INTRODUCTION

The leek (*Allium porrum* L.) is a herbaceous plant and a member of the alliaceae family. Leek is one of the economically most important field vegetable crops in many countries of the world (Benoit and Ceustermans, 1994). Leek, used for fresh consumption; in this respect, the leaves, long white blanched stem and bulb are eaten and cooked. These organs can also be added to salads or in soaps. Considered amounts of dried leek either green leaves and/or white blanched stems and bulbs were exported to many Europian countries .Also, it has a mild onion flavour with a delightful sweetness (Facciola, 1990). The bulb is said to be anthelmintic, antiaseptic, antispasmodic, diuretic, expectorant, febrifuge, stimutant, stomachic, tonic and vasodilator. The crached bulb may be applied as a poultice to ease the pain of bits, stings,.....etc (Launert, 1981; Grieve, 1984; and Holton and Hylton, 1979). In addition the whole plant is said to repel insects and moles (Riotte, 1978). The fertilization plays a very important role in leek productivity. To increase the yield potential of leek, the crop has been reported to respond to good soil fertility and adequate fertilizer (Thorup-Kristensen and Sorensen, 1998). Nitrogen and potassium are essential nutrients for plants and are regarded with phosphorus as three main macro-nutrients (Mengle and Kirkby, 1982). Although previous studies have addressed the relationship between N and K fertilizers on growth characters, yield and yield components of many plants (Huber, 1984; Sorensen 1993 and 1999; Savic *et al.*, 2004 and Lutvija *et al.*, 2005), have been largely ignored in leek. Thus, the study aims to evaluate the effect of K fertilization under different sources and levels of nitrogen on growth, yield and quality of leek., which can help in predicting the optimal N and K fertilizers requirement and improve the practice of leek production and quality.

MATERIALS AND METHODS

A field study was established on leek (cv. Cleopatra) during two successive seasons of 2003/2004 and 2004/2005 at a clay loam soil located at private farm, Tamiya, Fayoum Governorate, Egypt. Prior to the initiation of each season, soil samples to 30 cm depth from the experimental site were taken and analyzed according to published procedures (Wilde *et al.*, 1985). Data of some important physical and chemical analyses of the soil are given in Table (1). Imported leek seeds cv. Cleopatra, from Thompson-Morgan U.S.A. were sown in the nursery on 20^{th} July, 2003 and 2004 seasons. Fifty days after seed sowing, each seedling was transplanted into a plant bed in the field. Proceeding transplanting, roots and leaves of the transplants were trimmed according to the standard practices. The used experimental design was a split-split-plot in a randomized complete blocks with four replications. N-sources were allocated in the main plots, N-levels were assigned randomly to sub-plots, while K-levels were assigned randomly to sub-sub-plots. Each experimental unit consisted of 6 rows; 5 m long and 70 cm width; 21 m^2 (transplanting was 20 cm in-row spacing in both sides of each row). N-source treatments consisted of ammonium nitrate and urea at the levels of 100, 150, 200 and 250 Kg N $fed.^{-1}$ Nitrogen treatments were applied in 4 equal applications; 25% of the quantity was spread on the rows before transplanting and the rest of the amount was added at 30, 50 and 70 days from transplanting. Treatments comprised 2 levels of K; 48 and 96 Kg K_2O $fed.^{-1}$ Potassium sulphate (48% K_2O) was used as the respective K source and was side banded at two equal doses; 50 and 70 days from transplanting. All recommended cultural practices for growing leek were uniformly adapted according to crop requirements. After 90 days from transplanting, random sample of mature leaves of three plants was collected for determination of leaf pigments;total chlorophyll and carotenoids concentration(mg g^{-1} fresh weight of leaf). At the time of maturity, at 20^{th} and 23^{rd} of March 2004 and 2005, respectively, a random ten plants were collected from the two outer rows from each treatment to estimate the following parameters: plant height (cm), No. of leaves $plant^{-1}$, fresh and dry weight of leaves $plant^{-1}$ (g), raw fresh bulb weight (g), dry weight of bulb (g), total fresh and dry weights $plant^{-1}$ (g) were recorded. Also, whole plants were collected from the four inner rows from each plot and weighted then used for estimating the total yield (ton $feddan^{-1}$). Fresh samples of leaves and bulbs from ten plants were dried in a drying oven at 70°C for 72h to determine dry weight then ground and kept for chemical analysis. Also, whole plants were collected from the four inner rows from each plot and weighed then used for estimating the total bulb yield (ton $feddan^{-1}$).

Chemical analysis: leaf pigments; total chlorophyll and carotenoids were extracted by acetone 80% then determined using colorimetric method (Welburn and Lichtenthaler, 1984). In dried leaves and bulbs, nitrogen (%) was colorimetrically determined using the Orange-G dye (Hafez and Mikkelsen, 1981). Phosphorus (mg g^{-1} dry matter) was colorimetrically determined using chlorostannous molybdophosporic blue colour method in sulphuric acid system (Jackson, 1967). Potassium (mg g^{-1} dry matter) was determined using a Perkin Flame Photometer (Page *et al.*, 1982). For the nitrite and nitrate determination (mg g^{-1} dry weight), 0.5g dried material was shaken in 20 ml distilled water for 30 min., then filtered (Bar-Akiva, 1974). An aliquot of the extract was analyzed for nitrate using phenol disulfonic acid method (Page *et al.*, 1982). Another aliquot of the same extract was also analyzed for nitrite using sulphanilic acid and α-naphthylamine method (Chapman and Pratt, 1961).

Table (1): Some physical and chemical properties of the test soil in the seasons of 2003/2004 and 2004/2005.

Property	2003/2004	2004/2005
Particle size distribution:		
Clay%	32.8	29.5
Silt%	27.5	28.9
Sand%	39.7	41.6
Soil texture	Clay loam	Clay loam
Chemical:		
pH(1:2.5 suspension)	7.66	7.87
ECe(dSm^{-1})	1.67	1.72
Organic matter%	0.96	0.89
$CaCO_3$%	2.23	2.31
Soluble cations (meq100^{-1}g soil):		
Ca^{++}	1.69	1.74
Mg^{++}	1.37	1.18
Na^{+}	1.75	1.83
K^{+}	0.19	0.22
Soluble anions (meq100^{-1}g soil):		
Cl^{-}	1.48	1.70
HCO_3^{-}	1.51	1.11
CO_3^{--}	-	-
SO_4^{--}	2.03	2.21
Available nutrients (ppm)		
N	79	87
P	13.7	12.12
K	25.01	27.13

Statistical analysis:

All data were subjected to statistical analysis according to (Snedecor and Cochran, 1980). Comparisons of the means were carried out using the least significant difference (LSD) at p=0.05 level.

RESULTS AND DISCUSSION

I- growth characters:

The effect of nitrogen source and level as well as potassium fertilization on growth characteristics of leek cv. Cleopatra during the two successive seasons of 2003/2004 and 2004/2005 is shown in Tables (2, 3, 4 and 5). The comparisons among the mean values of the growth characteristics of leek showed that the main effect of nitrogen source, in general, was insignificant on plant height, No. of leaves plant-1, leaves fresh weight plant^{-1}, bulb fresh weight plant^{-1}, total plant fresh weight, leaves dry weight plant^{-1} and total plant dry weight in both seasons. Whereas, the total fresh weight plant^{-1} in the second season and bulb dry weight plant^{-1} in the first season were affected significantly by N source. Urea was superior over ammonium nitrate. Data in Tables (2, 3, 4 and 5) showed that the main effect of N level on all studied growth characters were significant and increased as the level increased and the trend was the same in both seasons. The main effect of potassium on leaves fresh weight plant^{-1}, bulb fresh and dry weight plant^{-1}, and total fresh and dry weight plant^{-1} was significant and the high level was superior and the trend was parallel in both seasons. however, plant height in the first season, No. of leaves plant^{-1} and leaves dry weight plant^{-1} in the second season were insignificantly affected. The interaction effect of source by nitrogen level which was presented in Tables (2, 3, 4 and 5) did not reflect a stable trend in both seasons. In general, insignificant effect on growth studied characters except leaves fresh and dry weight and total plant fresh weight in the second season beside bulb dry weight plant^{-1} in the first season has been detected. The interaction effect was significant and revealed that in each of the two used sources the vegetative characters increased with increasing N level. All other interaction levels did not affect the growth studied characters. Thus, the results showed that the studied growth characters react differentially to varying levels of nitrogen and/or potassium. The positive effect of mineral-N fertilization on growth characters of leek plants may be attributed to the role of nitrogen in protoplasm formation and all proteins, amino acids, nucleic acid, many enzymes and energy transfer materials; ADP and ATP (Russel, 1973), acceleration of both cell division and cell elongation and its great action in stimulating nutritional status and growth parameters (Medani *et al.*, 2000). The increase in No. of leaves plant^{-1} may be due to the abundance of N which would encourage the increasing number and/or cell size (Mills *et al.*, 1975) which was much more effective as the K was applied. Potassium has an important role in most physiological processes related to growth such as root-growth, water utilization efficiency, osmorgulation, transpiration, stomatal behaviour and general plant metabolism (Umar and Moinuddin, 2002). Also, K plays an important role in synthesis of most organic nutrients in the plant as well as it acts as an activator for a great number of enzymes which have a great role in stimulation of growth (Mansour and Hassan, 2004). It is generally recogonized that K deficiency suppresses plant growth and disturbs many aspects of leaf metabolites, such as carbohydrates concentration, as well as photosynthetic and translocation rates (Haeder and Mengel, 1972 and Huber, 1984). The enhancing effect of K fertilization on plant height and dry matter production of the aerial parts might be attributed to the function of K on cell division and cell elongation. In addtion, K raised the efficiency of carbohydrates synthesis and formation of protein compounds (Marschner, 1986). Results of these experiments complemented those of El-Morusy *et al.* (1998); Abd El-Momen *et al.* (2003) and Lutvija *et al.* (2005).

Table (2): Plant height and No. of leaves plant^{-1} of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Plant height (cm)						No. leaves plant^{-1}					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	125.00	113.00	119.00	96.33	118.67	107.50	12.67	13.33	13.00	13.67	12.67	13.17
	96	135.67	118.00	126.83	127.00	109.67	118.33	14.33	15.67	15.00	14.67	13.67	14.17
150	48	134.00	128.33	131.17	121.67	123.33	122.50	15.00	15.33	15.17	15.33	14.00	14.67
	96	130.00	124.67	127.33	132.00	132.00	132.00	15.67	15.67	15.67	13.33	14.33	13.83
200	48	136.33	130.33	133.33	135.33	130.00	132.67	16.00	15.33	15.67	14.67	16.00	15.33
	96	140.67	136.67	138.67	144.00	131.67	137.83	15.33	16.33	15.83	16.00	16.33	16.17
250	48	138.00	134.33	136.17	136.33	137.67	137.00	16.67	17.33	17.00	16.33	16.33	16.33
	96	139.67	137.33	138.50	142.33	145.33	143.83	18.33	16.00	17.17	16.67	17.00	16.83
Main effects	48	133.33	126.50	129.92	122.42	127.42	124.92	15.08	15.33	15.21	15.00	14.75	14.88
	96	136.50	129.17	132.83	136.33	129.67	133.00	15.92	15.92	15.92	15.17	15.33	15.25
100		130.33	115.50	122.92	111.67	114.17	112.92	13.50	14.50	14.00	14.17	13.17	13.67
150		132.00	126.50	129.25	126.83	127.67	127.25	15.33	15.50	15.42	14.33	14.17	14.25
200		138.50	133.50	136.00	139.67	130.83	135.25	15.67	15.83	15.75	15.33	16.17	15.75
250		138.83	135.83	137.33	139.33	141.50	140.42	17.50	16.67	17.08	16.50	16.67	16.58
	Avg.	134.92	127.83		129.38	128.54		15.50	15.63		15.08	15.04	
$LSD_{(0.05)}$													
N-Source (S)			n.s.			n.s.			n.s.			n.s.	
N-level (N)			10.52			9.91			1.11			0.72	
K-level (K)			n.s.			7.06			0.67			n.s.	
SxN			n.s.			n.s.			n.s.			n.s.	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			n.s.			n.s.			n.s.			n.s.	
SxNxK			n.s.			n.s.			n.s.			n.s.	

n.s.= not significant

Table (3): Leaves fresh weight plant^{-1} and raw bulb fresh weight of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Leaves fresh weight plant^{-1} (g)						Raw bulb fresh weight (g)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	589.76	464.32	527.04	538.62	464.06	501.34	92.19	102.72	97.46	144.10	85.34	114.72
	96	734.64	699.88	717.26	742.09	575.92	659.00	135.47	164.56	150.01	176.91	136.98	156.94
150	48	753.68	783.02	768.35	762.24	724.93	743.59	180.69	155.76	168.22	197.16	174.66	185.91
	96	822.74	829.45	826.09	785.25	781.96	783.61	186.79	193.50	190.15	205.42	187.22	196.32
200	48	856.48	813.70	835.09	742.74	850.25	796.50	227.91	221.93	224.92	214.11	213.79	213.95
	96	926.14	857.54	891.84	849.15	853.94	851.55	275.45	261.85	268.65	244.67	219.98	232.33
250	48	942.74	971.42	957.08	926.73	945.56	936.15	276.54	270.34	273.44	249.92	258.82	254.37
	96	1100.76	897.09	998.92	942.12	985.58	963.85	274.61	335.46	305.04	290.02	255.80	272.91
Main effects	48	785.66	758.11	771.89	742.58	746.20	744.39	194.33	187.69	191.01	201.32	183.15	192.24
	96	896.07	820.99	858.53	829.65	799.35	814.50	218.08	238.84	228.46	229.25	200.00	214.62
100		662.20	582.10	622.15	640.36	519.99	580.17	113.83	133.64	123.74	160.51	111.16	135.83
150		788.21	806.23	797.22	773.74	753.45	763.60	183.74	174.63	179.18	201.29	180.94	191.11
200		891.31	835.62	863.47	795.95	852.10	824.02	251.68	241.89	246.78	229.39	216.89	223.14
250		1021.75	934.26	978.00	934.43	965.57	950.00	275.58	302.90	289.24	269.97	257.31	263.64
100	Avg.	840.87	789.55		786.12	772.78		206.21	213.27		215.29	191.58	
$LSD_{(0.05)}$													
N-Source (S)			n.s.			n.s.			n.s.			n.s.	
N-level (N)			83.38			64.83			20.52			19.55	
K-level (K)			82.78			67.29			19.89			17.34	
SxN			n.s.			91.68			n.s.			n.s.	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			n.s.			n.s.			n.s.			n.s.	
SxNxK			n.s.			n.s.			n.s.			n.s.	

n.s.= not significant

Table (4): Total plant fresh weight and leaves dry weight plant^{-1} of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Total plant fresh weight (g)						Leaves dry weight plant^{-1} (g)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	681.95	567.04	624.50	682.72	549.40	616.06	51.25	38.67	44.96	59.81	42.62	51.21
	96	870.11	864.44	867.27	919.00	712.90	815.95	59.61	73.44	66.53	65.99	56.06	61.02
150	48	934.36	938.78	936.57	959.40	899.59	929.49	70.86	71.56	71.21	64.01	72.57	68.29
	96	919.53	1021.95	970.74	990.66	969.19	979.93	83.67	69.33	76.50	66.76	77.09	71.92
200	48	1084.36	1035.63	1059.99	956.85	1064.04	1010.45	67.08	77.52	72.30	73.15	80.87	77.01
	96	1201.59	1119.39	1160.49	1093.82	1073.92	1083.87	76.64	88.91	82.78	74.78	80.51	77.64
250	48	1219.55	1241.77	1230.66	1176.65	1204.38	1190.52	84.64	89.62	87.13	81.73	87.85	84.79
	96	1375.37	1232.49	1303.93	1232.15	1241.39	1236.77	95.16	90.23	92.70	91.10	90.23	90.67
Main effects	48	980.06	945.80	962.93	943.91	929.36	936.63	68.46	69.34	68.90	69.68	70.98	70.33
	96	1091.65	1059.57	1075.61	1058.91	999.35	1029.13	78.77	80.48	79.62	74.66	75.97	75.31
100		776.03	715.74	745.88	800.86	631.15	716.01	55.43	56.05	55.74	62.90	49.34	56.12
150		926.95	980.36	953.65	975.03	934.39	954.71	77.27	70.44	73.86	65.38	74.83	70.11
200		1142.98	1077.51	1110.24	1025.34	1068.98	1047.16	71.86	83.22	77.54	73.97	80.69	77.33
250		1297.46	1237.13	1267.29	1204.40	1222.89	1213.64	89.90	89.92	89.91	86.42	89.04	87.73
	Avg.	1035.85	1002.68		1001.41	964.35		73.62	74.91		72.17	73.47	
$LSD_{(0.05)}$													
N-Source (S)		n.s.			16.00			n.s.			n.s.		
N-level (N)		104.99			63.90			12.74			7.83		
K-level (K)		91.13			66.96			6.95			n.s.		
SxN		n.s.			90.37			n.s.			11.07		
SxK		n.s.			n.s.			n.s.			n.s.		
NxK		n.s.			n.s.			n.s.			n.s.		
SxNxK		n.s.			n.s.			n.s.			n.s.		

n.s.= not significant

Table (5): Bulb dry weight and total dry weight plant^{-1} of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Bulb dry weight (g)						Total dry weight plant^{-1} (g)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	16.12	16.84	16.48	21.07	14.72	17.90	67.37	55.51	61.44	80.88	57.34	69.11
	96	21.36	31.67	26.52	30.40	23.03	26.71	80.98	105.11	93.04	96.39	79.09	87.74
150	48	29.62	25.16	27.39	30.72	29.07	29.89	100.49	96.72	98.60	94.73	101.64	98.18
	96	27.72	33.68	30.70	41.32	31.82	36.57	111.39	103.01	107.20	108.08	108.91	108.49
200	48	34.04	39.92	36.98	34.28	36.68	35.48	101.12	117.44	109.28	107.44	117.56	112.50
	96	34.83	40.96	37.90	37.89	38.33	38.11	111.47	129.87	120.67	112.67	118.83	115.75
250	48	38.45	50.85	44.65	47.10	43.22	45.16	123.09	140.46	131.78	128.83	131.08	129.96
	96	34.41	57.47	45.94	52.48	42.45	47.47	129.57	147.70	138.64	143.58	132.68	138.13
Main effects	48	29.56	33.19	31.37	33.29	30.92	32.11	98.02	102.53	100.27	102.97	101.90	102.44
	96	29.58	40.95	35.26	40.52	33.91	37.21	108.35	121.42	114.89	115.18	109.88	112.53
100		18.74	24.25	21.50	25.73	18.88	22.30	74.17	80.31	77.24	88.63	68.21	78.42
150		28.67	29.42	29.05	36.02	30.44	33.23	105.94	99.86	102.90	101.40	105.27	103.34
200		34.44	40.44	37.44	36.09	37.51	36.80	106.30	123.65	114.98	110.05	118.20	114.12
250		36.43	54.16	45.30	49.79	42.84	46.31	126.33	144.08	135.21	136.21	131.88	134.04
	Avg.	29.57	37.07		36.91	32.42		103.19	111.98		109.07	105.89	
$LSD_{(0.05)}$													
N-Source (S)		5.89			n.s.			n.s.			n.s.		
N-level (N)		4.94			3.42			15.14			7.17		
K-level (K)		3.66			3.88			8.57			8.03		
SxN		6.99			n.s.			n.s.			n.s.		
SxK		n.s.			n.s.			n.s.			n.s.		
NxK		n.s.			n.s.			n.s.			n.s.		
SxNxK		n.s.			n.s.			n.s.			n.s.		

n.s.= not significant

II- Total yield:

Data presented in Table (6) showed the main effect of nitrogen source and level as well as potassium fertilization and their interactions on total yield of leek during the two successive seasons of 2003/2004 and 2004/2005. As for the main effect of N source, the data reflected that leek yield which produced from urea fertilization scored the higher values than those produced from ammonium nitrate treatments, although the difference did not reach the level of significance. The increments of urea yields were 6.98% and 2.96% over ammonium nitrate yields in the season of 2003/2004 and 2004/2005, respectively. Data tabulated in Table (6) clarify the main effect of N levels on leek yield fed.$^{-1}$. The data reflected significant differences among treatments with every increment in N level. The increments in yield between 100 and 150, 150 and 200 as well as 200 and 250 kg N fed.$^{-1}$ were 27.23%, 18.59% and 15.33% and were 29.36%, 10.57% and 13.2% in the first and the second seasons, respectively.

The main effect of potassium fertilization on yield was significant as shown in Table (6). The data showed higher yield values with the higher K level, the effect of the higher level was superior which recorded 10.84% and 8.42% higher than the low level of K in the first and second seasons, respectively. No significant effects were detected with the interactions between the three factors under studying on yield of leek in both seasons except the interaction effect of N by K, the effect was significant only in the second season and the data reflected that in any certain K level, leek yield increased with increasing N level.

The increase in total yield of leek is expected as the level of mineral-N fertilizer was raised from 100 to 250 Kg fed.$^{-1}$ for leek plants which could be explained from the major functions of nitrogen on growth and metabolism. Nitrogen is highly effective on growth and yield through its effect on vital processes, i.e. chlorophyll, enzymes, photosynthesis and endogenous hormones synthesis, which consequently affect plant growth and yield (Marschner, 1995 and Hanafy, 1997). Hanafy (1986 and 1997) working on sweet pepper and squash plants, respectively, suggested that the increases in fruit yield under sufficient supply of nitrogen might be attributed to the supply of assimilates from the leaves to the fruits as a result of, (a) an increase in the available leaf assimilates supply to the fruits, (b) an increase in potential sink strength of fruit and/or (c) an increase in translocation capacity. The positive effect of K fertilization in leek is probably due to the increase in photosynthesis, the transport of assimilates to the bulbs, increased root growth, or a combination of these factors (Duke and Collins, 1985). Thus, improved nutrition of leek may thus help in sustaining the productivity of better quality leek.

III- Chemical constituents:

(a)- Leaf pigments.

The presented results in Table (7) reveal that, in both seasons, leaves concentration of total chlorophyll and carotenoids was affected by the application of nitrogen and potassium treatments. In this respect, the main effect of nitrogen source reflect, in general, that the plants which received urea as N-source, tended to give the highest values for total chlorophyll as compared to NO_3-N ones while, the plants treated with NO_3-N gave the highest values for carotenoids as compared to urea-N ones in both seasons. Concerning the main effect of N-level, the concentration of total chlorophyll and carotenoids was significantly enhanced as N-level increased in both seasons. The concentration of both chlorophyll and carotenoids tended to increase with K fertilization with increasing level although the differences did not reach the level of significance in both seasons. The interaction effect of N-source by N-level on total chlorophyll did not reflect any significance in both seasons, whereas, the interaction gave a marked effect on total carotenoids in both seasons. The data reflected that with certain source of N, total carotenoids increased with every increment of N level. All other interaction levels did not affect the concentration of total chlorophyll and carotenoids in both seasons.

(b)- Nitrogen (N), phosphorus (P) and potassium (K):

The concentrations of N, P and K in the leaves and bulbs of leek as affected by different fertilization treatments of nitrogen and potassium are shown in Tables (8, 9 and 10). Data in Table (8) indicate that N concentration of leaves and bulbs was affected by N-source. The plants which received NO_3 as N-source, gave the highest value for N concentration in both leaves and bulbs to different extents. The main effects of N-level on the concentration of N leaves and bulbs were significant and increased as the N-level increased. As for the effect of K, data in Table (8) showed that K fertilization had a marked effect on N concentration, and reflected that the higher K level increased N concentration in leek leaves and bulbs than the lower level. No significant interactive effects were detected in this phenomenon in both seasons except a non stable positive effect of N by K and source by N by K in leaves.

Data presented in Table (9) showed the main effects of the three studied factors and their interactions on P concentration in leek leaves and bulbs during the seasons of 2003/2004 and 2004/2005. The results reflected marked effects and showed that P concentration increased in both leaves and bulbs with urea N source than with NO_3 source. Also, P concentration increased significantly with increasing N level in both leaves and bulbs. Moreover, data in Table (9) revealed that P concentration in leaves and bulbs significantly increased with the higher level of K than with the lower one and the trend was the same in both seasons. The data in Table (9) showed that the interaction between N source and N level showed no marked influence on P concentration except in bulbs of leek in the second season which exhibit a remarkable increase of P concentration with every increase of N level in a certain N source.

With regard to the effect of N and K treatments on K concentration of leaves and bulbs of leek, data presented in Table (10) indicate that the plants treated with urea-N gave greater values for K concentration in leaves and bulbs while NO_3-treated ones gave the lowest values in both seasons. The main effect of N-level shows that, increasing N-level, K concentration in both leaves and bulbs was increased and the trend was the same in both seasons. Also, the data tabulated in Table (10) showed that K concentration in leek leaves and bulbs increased significantly with the higher K level in both seasons. No significant interaction effects were detected except the effect of N by K which showed that K concentration in bulbs was significantly increased with every increment of N level in any K level in both seasons.

Table (6): Total yield of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Total yield (ton fed.$^{-1}$)					
		First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	33.86	28.35	31.10	34.88	27.99	31.43
	96	42.09	42.46	42.27	46.27	40.60	43.44
150	48	47.76	44.28	46.02	49.27	46.27	47.77
	96	49.63	45.07	47.35	49.51	48.64	49.08
200	48	53.69	52.10	52.89	52.73	53.47	53.10
	96	60.15	55.52	57.84	54.76	53.20	53.98
250	48	62.62	61.70	62.16	57.92	61.32	59.62
	96	69.08	62.01	65.54	60.52	62.66	61.59
Main effects	48	49.48	46.61	48.04	48.70	47.26	47.98
	96	55.24	51.27	53.25	52.77	51.27	52.02
100		37.97	35.41	36.69	40.58	34.29	37.43
150		48.69	44.68	46.68	49.39	47.45	48.42
200		56.92	53.81	55.36	53.75	53.34	53.54
250		65.85	61.86	63.85	59.22	61.99	60.61
	Avg.	52.36	48.94		50.73	49.27	
$LSD_{(0.05)}$							
N-Source (S)			n.s.			n.s.	
N-level (N)			4.74			3.85	
K-level (K)			4.37			2.80	
SxN			n.s.			n.s.	
SxK			n.s.			n.s.	
NxK			n.s.			5.60	
SxNxK			n.s.			n.s.	

n.s.= not significant

(c)- Nitrite (NO_2) and nitrate (NO_3).

Differences in NO_2 and NO_3 concentration in leaves and bulbs of leek in both seasons among all treatments are shown in Tables (11 and 12). The main effects of N-source indicate that; the plants treated with urea-N gave the lowest values for NO_2 and NO_3 while, NO_3-treated ones gave the highest values in leaves and bulbs in both seasons. As for N-level effects, N application increased both NO_2 and NO_3 concentration in leaves and bulbs of leek in both seasons. On the other hand, data tabulated in Tables(11 and 12) showed the main effect of K and indicated that raising K level lowered significantly the concentration of NO_2 and NO_3 in both leaves and bulbs of leek in both seasons. All the interaction levels had pronounced effects on the concentrations of both NO_2 and NO_3 in leaves and bulbs of leek in both seasons (Tables 11 and 12). The interaction effect of S by N level reflect a significant increase in NO_2 and NO_3 concentrations with every increment of N level in any N source except NO_2 concentration in bulbs in the second season and the effect does not reach the level of significance The same trend was noticed with the interaction between N by K, in certain K level increasing N level increased, NO_2 and NO_3 concentrations. On the other hand, the effect of S by K, the data showed that in certain N source NO_2 and NO_3 concentrations decreased in leaves and bulbs with the higher K level than with the lower one except in bulbs NO_2 concentration was not affected in the first season only. The interactive effect between S by N by K was significant and reflected the effect of raising K level, it decreased the effect of both N level and the NO_3 source than the urea source in increasing NO_2 and NO_3 concentrations in both leaves and bulbs of leek and the trend was parallel in both seasons.

Thus, the favorable effect of nitrogen (irrespective N-source) in enhancing leaf pigments; chlorophyll and carotenoids with increasing the level of nitrogen may be explained on the basis that nitrogen is an integral part of chlorophyll and carotenoids and is essential for synthesis of them (Baker, 1998). Although potassium is known neither to be a constituent of chlorophyll nor does it plays a direct role in chlorophyll biosynthesis, it improves the chlorophyll content. It is presumably due to the role of K in photosynthesis providing raw materials and tools for general plant metabolism inducing chlorophyll synthesis. In addition, K application has been ascribed to the favorable effect of K application on uptake of ions as SO_4^{-2}, Fe^{+2} and Mg^{+2} that are known to be associated with chlorophyll synthesis (Umar and Moinuddin, 2002). The results are confirmed with those of Wolf *et al.* (1976) who mentioned that the availability of K has been linked to increase chlorophyll content of leaves.

Increasing N, P and K concentrations by N fertilization might be due to that, they increased the plant capacity to absorb nutrients. This might be attributed to the increase in roots surface per unit of soil volume as well as the high capacity of the plants supplied with N fertilizer in building metabolites, which in turn contribute much to the increase of nutrient uptake (Mandour *et al.* 1986 and Mohamed and Matter, 2001). The stimulating effect of N on P uptake by plants may be attributed to: (a)- A great root expansion in response to N application (Drew and Saker, 1975), given that the uptake of low-mobility nutrients such as P is heavily swayed by the root morphology and physiology (Adalsteinson and Jensen, 1989); (b)- Soil-P availability, altered by chemical and acidity changes in the rhizosphere (Hoffland *et al.*, 1989); and (c)-

Physiological changes stimulated by N, which influence P transport within the plant (Lamaze *et al.*, 1984). A similar trend to the current results was found by Abdel-Hamid *et al.* (1992) who concluded that application of K increased N, P and K content of leaves of foldder beet. Mengel and Kirkby (1982) found that tobacco plants absorbed higher ^{15}N in the K^+ treatment. El-Bialy *et al.* (2001) mentioned that application of K increased the uptake of K in vegetative growth organs of wheat.

The accumulation of NO_3^- in the plant is a natural phenomenon that occurs when the uptake of NO_3^- by the roots exceeds its reduction and subsequent metabolism within the plant (Hanafy *et al.*, 1997 and 2002a). Most of the nitrate is accumulated in the leaves, especially in the mesophyll (Mills and Jones, 1979).

All species grown on urea-N fertilizer contained low amounts of NO_3^- as compared to the other fertilizers (Lahav *et al*., 1976). Within limits, the form of applied N has an effect on NO_3^- accumulation (Peck *et al*., 1971). To some extent, the longer the plant is in contact with NO_3^-, the greater will be the tendency to accumulate NO_3^- (Maynard *et al*., 1976). Thus, urea fertilizers may result in less accumulation of plant NO_3^- than NO_3^- fertilized ones (Peck *et al*., 1971). However, the results obtained coincided with these findings. It can be suggested that, under some nitrogen sources, plants may absorb great quantity of nitrogen than its assimilation capacity. The difference between N-absorption and assimilation will be great and the unutilized N will be stored as nitrate in plant tissues (Rufty *et al*., 1982; Hanafy *et al*., 1997; and Pechova *et al*., 1998). or nitrate reductase (Nottón and Hewitt, 1979 and Mengel and Kirkby, 1982). The addition of nitrate fertilizers directly increased the NO_3^- ions concentration in soil which consequently increased NO_3-N concentration in plant tissues. Whereas, other nitrogen fertilizer such urea-N could be converted to NO_3^- after nitrification, yet it needs some time (Minotti, 1975 and Maynard *et al*., 1976). The slower nitrification rate with the sources containing urea-N was considered to be the cause for the initially lower of NO_3-N level (Gardner and Pew, 1979). It may be concluded that NO_3^- accumulation is not a simple subject but a complicated system involving many physiological processes (Blom-Zandstra, 1989). Thus, the problem of nitrate accumulation in spinach is mainly due to conflicting interest and the different interpretation of the word quality. It is a conflict between high productivity and marketability on one hand, and safety on the other. A similar trend to the current results was obtained by Salman *et al*., 2000; Abd El-Rahman *et al*., 2001; Hanafy *et al*., 2002 a & b and Gadallah *et al*., 2004). The concentration of NO_3^- in plant tissues is always in a dynamic state that since it represents the differences between rate of N-absorption and rates of translocation and assimilation within the plant. These results confirmed the suggestion that several plants species accumulate NO_3^-as a result of excess of N uptake over its reduction (Hanafy, 1997 and Hanafy *et al* 2000). Moreover, Rufty *et al*. (1982) reported that NO_3^- is believed to accumulate in a storage pool; presumably in the vacuoles, from which it is not readily available.

In nitrogen metabolism of plants, K has been reported to stimulate the activity of nitrate reductase, to promote the formation of peptides and proteins (Mengel and Kirkby, 1982). The authors found that tobacco plants absorbed higher ^{15}N in the K^+ treatment and a more efficient reduction of NO_3^-as well as a faster conversion of amino acids into proteins. This process indicates the essentiality of an optimal K nutrition for leek in obtaining high yield and quality of leek. These results are in agreement with those obtained by Ondes and Zabunoglu (1991)

Finally, The results of this study showed that the application of urea-N at the rate of 250 Kg fed.$^{-1}$ and K at the rate of 96 Kg fed.$^{-1}$ was found to be the best dose of fertilizer and may be recommended for the highest growth, yield and quality of leek.

Table (7): Total chlorophyll and total carotenoids concentration in leaves of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	Total chlorophyll (mg g^{-1}fresh wt. of leaves)						Total carotenoids (mg g^{-1}fresh wt. of leaves)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	0.743	0.472	0.608	0.666	0.502	0.584	0.505	0.724	0.615	0.533	0.668	0.601
	96	0.761	0.605	0.658	0.658	0.557	0.607	0.600	0.734	0.667	0.549	0.682	0.616
150	48	0.970	0.795	0.883	1.066	0.735	0.901	0.477	0.605	0.541	0.517	0.584	0.551
	96	1.010	0.809	0.910	1.106	0.792	0.949	0.505	0.622	0.564	0.522	0.619	0.571
200	48	1.033	0.922	0.978	1.175	1.008	1.091	0.467	0.532	0.500	0.497	0.573	0.535
	96	1.283	0.963	1.123	1.341	0.965	1.153	0.468	0.545	0.507	0.490	0.560	0.525
250	48	1.345	1.142	1.244	1.350	1.081	1.215	0.395	0.416	0.405	0.476	0.498	0.487
	96	1.377	1.073	1.225	1.313	1.051	1.182	0.385	0.449	0.417	0.417	0.516	0.467
Main effects	48	1.023	0.833	0.928	1.064	0.831	0.948	0.461	0.569	0.515	0.506	0.581	0.543
	96	1.095	0.863	0.979	1.104	0.841	0.973	0.490	0.588	0.539	0.495	0.594	0.544
100		0.727	0.539	0.633	0.662	0.530	0.596	0.553	0.729	0.641	0.541	0.675	0.608
150		0.990	0.802	0.896	1.086	0.763	0.925	0.491	0.614	0.552	0.520	0.602	0.561
200		1.158	0.943	1.050	1.258	0.986	1.122	0.468	0.539	0.503	0.494	0.567	0.530
250		1.361	1.108	1.234	1.331	1.066	1.199	0.390	0.432	0.411	0.447	0.507	0.477
	Avg.	1.059	0.848		1.084	0.836		0.475	0.578		0.500	0.588	
LSD$_{(0.05)}$													
N-Source (S)			0.201			n.s.			0.018			0.054	
N-level (N)			0.122			0.107			0.034			0.025	
K-level (K)			n.s.			n.s.			0.017			n.s.	
SxN			n.s.			n.s.			0.048			0.036	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			n.s.			n.s.			n.s.			n.s.	
SxNxK			n.s.			n.s.			n.s.			n.s.	

n.s.= not significant

Table (8): Nitrogen (N) concentration in leaves and bulb of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	N (mg g^{-1} dry matter of leaves)						N (mg g^{-1} dry wt. of bulb)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	2.03	2.54	2.29	1.78	2.28	2.03	1.76	2.03	1.90	1.48	1.52	1.50
	96	2.54	2.79	2.67	2.28	2.54	2.41	1.78	2.28	2.03	1.52	1.78	1.65
150	48	2.79	3.05	2.92	2.28	2.54	2.41	2.03	2.28	2.16	1.78	1.96	1.87
	96	2.79	3.05	2.92	2.55	2.79	2.67	2.28	2.54	2.41	2.03	2.28	2.16
200	48	2.85	3.05	2.95	2.55	3.05	2.80	2.03	2.28	2.16	2.03	2.28	2.16
	96	3.05	3.55	3.30	2.79	3.05	2.92	2.45	2.79	2.62	2.28	2.54	2.41
250	48	3.28	3.55	3.42	3.05	3.05	3.05	2.54	2.79	2.67	2.54	2.54	2.54
	96	3.55	3.81	3.68	3.05	3.55	3.30	2.79	2.96	2.88	2.54	2.79	2.67
Main effects	48	2.74	3.05	2.89	2.42	2.73	2.57	2.09	2.35	2.22	1.96	2.08	2.02
	96	2.98	3.30	3.14	2.67	2.98	2.83	2.33	2.64	2.48	2.09	2.35	2.22
100		2.29	2.67	2.48	2.03	2.41	2.22	1.77	2.16	1.96	1.50	1.65	1.58
150		2.79	3.05	2.92	2.42	2.67	2.54	2.16	2.41	2.28	1.91	2.12	2.01
200		2.95	3.30	3.13	2.67	3.05	2.86	2.24	2.54	2.39	2.16	2.41	2.28
250		3.42	3.68	3.55	3.05	3.30	3.18	2.67	2.88	2.77	2.54	2.67	2.60
	Avg.	2.86	3.17		2.54	2.86		2.21	2.49		2.03	2.21	
$LSD_{(0.05)}$													
N-Source (S)			0.07			0.09			0.16			0.03	
N-level (N)			0.07			0.15			0.10			0.11	
K-level (K)			0.09			0.08			0.09			0.08	
SxN			n.s.			n.s.			n.s.			n.s.	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			0.19			n.s.			n.s.			n.s.	
SxNxK			n.s.			0.22			n.s.			n.s.	

n.s.= not significant

Table (9): Phosphorus (P) concentration in leaves and bulb of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	P (mg g^{-1} fresh wt. of leaves)						P (mg g^{-1} fresh wt. of bulb)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	0.025	0.014	0.020	0.025	0.012	0.019	0.012	0.007	0.010	0.011	0.009	0.010
	96	0.029	0.018	0.024	0.032	0.016	0.024	0.019	0.009	0.014	0.012	0.009	0.011
150	48	0.033	0.021	0.027	0.033	0.020	0.027	0.022	0.012	0.017	0.019	0.011	0.015
	96	0.038	0.022	0.030	0.036	0.026	0.031	0.025	0.014	0.020	0.022	0.014	0.018
200	48	0.037	0.025	0.031	0.035	0.027	0.031	0.027	0.015	0.021	0.027	0.018	0.023
	96	0.043	0.029	0.036	0.036	0.030	0.033	0.032	0.018	0.025	0.032	0.021	0.027
250	48	0.043	0.033	0.038	0.041	0.028	0.035	0.036	0.028	0.032	0.038	0.022	0.030
	96	0.049	0.036	0.043	0.043	0.032	0.038	0.033	0.032	0.033	0.040	0.028	0.034
Main effects	48	0.035	0.023	0.029	0.034	0.022	0.028	0.024	0.016	0.020	0.024	0.015	0.019
	96	0.040	0.026	0.033	0.037	0.026	0.031	0.027	0.018	0.023	0.027	0.018	0.022
100		0.027	0.016	0.022	0.029	0.014	0.021	0.016	0.008	0.012	0.012	0.009	0.010
150		0.036	0.022	0.029	0.035	0.023	0.029	0.024	0.013	0.018	0.021	0.013	0.017
200		0.040	0.027	0.034	0.036	0.029	0.032	0.030	0.017	0.023	0.030	0.020	0.025
250		0.046	0.035	0.040	0.042	0.030	0.036	0.035	0.030	0.032	0.039	0.025	0.032
	Avg.	0.037	0.025		0.035	0.024		0.026	0.017		0.025	0.017	
$LSD_{(0.05)}$													
N-Source (S)			0.004			0.006			0.002			0.001	
N-level (N)			0.002			0.005			0.004			0.003	
K-level (K)			0.003			0.003			0.002			0.002	
SxN			n.s.			n.s.			n.s.			0.005	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			n.s.			n.s.			n.s.			n.s.	
SxNxK			n.s.			n.s.			n.s.			n.s.	

Table (10): Potassium (K) concentration in leaves and bulb of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N $fed.^{-1}$)	K-level (kg K_2O $fed.^{-1}$)	K ($mg\ g^{-1}$ dry wt. of leaves)						K ($mg\ g^{-1}$ dry wt. of bulb)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	4.30	2.57	3.43	4.80	2.70	3.75	19.70	13.60	16.65	21.20	16.10	18.65
	96	4.77	3.40	4.08	5.20	3.50	4.35	19.90	14.40	17.15	22.90	17.50	20.20
150	48	5.03	3.57	4.30	5.30	4.60	4.95	22.40	16.00	19.20	24.90	17.80	21.35
	96	6.03	3.80	4.92	5.90	5.40	5.65	24.40	16.80	20.60	27.40	19.40	23.40
200	48	6.87	4.40	5.63	6.90	5.20	6.05	24.00	17.60	20.80	27.50	20.30	23.90
	96	7.40	4.77	6.08	7.80	5.90	6.85	31.20	20.80	26.00	30.80	22.70	26.75
250	48	7.20	4.87	6.03	8.40	6.10	7.25	28.60	20.20	24.40	30.20	23.10	26.65
	96	8.03	5.30	6.67	8.80	6.50	7.65	33.60	22.80	28.20	33.70	24.80	29.25
Main effects	48	5.85	3.85	4.85	6.35	4.65	5.50	23.68	16.85	20.26	25.95	19.33	22.64
	96	6.56	4.32	5.44	6.93	5.33	6.13	27.28	18.70	22.99	28.70	21.10	24.90
100		4.53	2.98	3.76	5.00	3.10	4.05	19.80	14.00	16.90	22.05	16.80	19.43
150		5.53	3.68	4.61	5.60	5.00	5.30	23.40	16.40	19.90	26.15	18.60	22.38
200		7.13	4.58	5.86	7.35	5.55	6.45	27.60	19.20	23.40	29.15	21.50	25.33
250		7.62	5.08	6.35	8.60	6.30	7.45	31.10	21.50	26.30	31.95	23.95	27.95
	Avg.	6.20	4.08		6.64	4.99		25.48	17.78		27.33	20.21	
$LSD_{(0.05)}$													
N-Source (S)			0.36			1.27			3.74			2.40	
N-level (N)			0.50			0.81			2.32			1.94	
K-level (K)			0.43			0.57			1.05			1.46	
SxN			n.s.			n.s.			n.s.			n.s.	
SxK			n.s.			n.s.			n.s.			n.s.	
NxK			n.s.			n.s.			2.09			2.30	
SxNxK			n.s.			n.s.			n.s.			n.s.	

n.s.= not significant

Table (11): Nitrite (NO_2) in leaves and bulb of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	NO_2 (mg kg^{-1} dry wt. of leaves)						NO_2 (mg kg^{-1} dry wt. of bulb)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	0.030	0.050	0.040	0.030	0.050	0.040	0.033	0.040	0.037	0.020	0.040	0.030
	96	0.020	0.040	0.030	0.030	0.040	0.035	0.020	0.030	0.025	0.020	0.040	0.030
150	48	0.040	0.070	0.055	0.040	0.070	0.055	0.040	0.050	0.045	0.030	0.050	0.040
	96	0.030	0.060	0.045	0.030	0.060	0.045	0.040	0.050	0.045	0.030	0.050	0.040
200	48	0.060	0.080	0.070	0.050	0.080	0.065	0.050	0.060	0.055	0.050	0.060	0.055
	96	0.040	0.070	0.055	0.040	0.070	0.055	0.040	0.060	0.050	0.030	0.060	0.045
250	48	0.063	0.120	0.092	0.060	0.093	0.077	0.050	0.090	0.070	0.060	0.080	0.070
	96	0.060	0.080	0.070	0.060	0.080	0.070	0.050	0.070	0.060	0.050	0.070	0.060
Main effects	48	0.048	0.080	0.064	0.045	0.073	0.059	0.043	0.060	0.052	0.040	0.058	0.049
	96	0.038	0.063	0.050	0.040	0.063	0.051	0.038	0.053	0.045	0.033	0.055	0.044
100		0.025	0.045	0.035	0.030	0.045	0.038	0.027	0.035	0.031	0.020	0.040	0.030
150		0.035	0.065	0.050	0.035	0.065	0.050	0.040	0.050	0.045	0.030	0.050	0.040
200		0.050	0.075	0.063	0.045	0.075	0.060	0.045	0.060	0.053	0.040	0.060	0.050
250		0.062	0.100	0.081	0.060	0.087	0.073	0.050	0.080	0.065	0.055	0.075	0.065
	Avg.	0.043	0.071		0.043	0.068		0.040	0.056		0.036	0.056	
$LSD_{(0.05)}$													
N-Source (S)			0.002			0.002			0.002			0.003	
N-level (N)			0.003			0.001			0.001			0.002	
K-level (K)			0.002			0.001			0.001			0.002	
SxN			0.004			0.002			0.002			n.s.	
SxK			0.003			0.001			n.s.			0.002	
NxK			0.005			0.002			0.002			0.003	
SxNxK			0.007			0.002			0.002			0.004	

n.s.= not significant

Table (12): Nitrate (NO_3) in leaves and bulb of leek as affected by nitrogen and potassium fertilization in the seasons of 2003/2004 and 2004/2005.

N-level (kg N fed.$^{-1}$)	K-level (kg K_2O fed.$^{-1}$)	NO_3 (mg kg^{-1} dry wt. of leaves)						NO_3 (mg kg^{-1} dry wt. of bulb)					
		First season			Second season			First season			Second season		
		Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.	Urea	NH_4NO_3	Avg.
100	48	0.45	0.62	0.54	0.35	0.61	0.48	0.38	0.62	0.50	0.32	0.60	0.46
	96	0.27	0.58	0.43	0.28	0.58	0.43	0.32	0.60	0.46	0.28	0.59	0.44
150	48	0.49	0.89	0.69	0.46	0.86	0.66	0.54	0.69	0.62	0.53	0.71	0.62
	96	0.46	0.84	0.65	0.46	0.83	0.65	0.52	0.67	0.60	0.38	0.68	0.53
200	48	0.58	0.99	0.79	0.58	0.98	0.78	0.51	0.78	0.65	0.58	0.78	0.68
	96	0.52	0.90	0.71	0.52	0.90	0.71	0.57	0.75	0.66	0.58	0.71	0.65
250	48	0.80	1.32	1.06	0.78	1.57	1.18	0.68	1.12	0.90	0.66	1.05	0.86
	96	0.75	1.04	0.90	0.72	1.02	0.87	0.66	0.91	0.79	0.62	0.91	0.77
Main effects	48	0.58	0.96	0.77	0.54	1.01	0.77	0.53	0.80	0.67	0.52	0.79	0.65
	96	0.50	0.84	0.67	0.50	0.83	0.66	0.52	0.73	0.63	0.47	0.72	0.59
100		0.36	0.60	0.48	0.32	0.60	0.46	0.35	0.61	0.48	0.30	0.60	0.45
150		0.48	0.87	0.67	0.46	0.85	0.65	0.53	0.68	0.61	0.46	0.70	0.58
200		0.55	0.95	0.75	0.55	0.94	0.75	0.54	0.77	0.65	0.58	0.75	0.66
250		0.78	1.18	0.98	0.75	1.30	1.02	0.67	1.02	0.84	0.64	0.98	0.81
	Avg.	0.54	0.90		0.52	0.92		0.52	0.77		0.49	0.75	
$LSD_{(0.05)}$													
N-Source (S)			0.01			0.01			0.01			0.01	
N-level (N)			0.01			0.01			0.01			0.01	
K-level (K)			0.01			0.01			0.01			0.01	
SxN			0.01			0.01			0.01			0.01	
SxK			0.01			0.01			0.01			0.01	
NxK			0.01			0.01			0.01			0.01	
SxNxK			0.01			0.01			0.01			0.01	

n.s.= not significant

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استجابة النمو والقدرة الإنتاجية للكرات للتسميد النتروجينى والبوتاسى

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أجريت هذه الدراسة خلال موسمين متتاليين هما ٢٠٠٣/٢٠٠٤ و٢٠٠٤/٢٠٠٥ بمزرعة خاصة بمركز طامية-محافظة الفيوم-مصر، لمعرفة تأثير التسميد النتروجينى والبوتاسى على النمو والقدرة الإنتاجية لنبات الكرات (صنف كليوباترا).وقد تم إضافة السماد النتروجينى بمعدلات ١٠٠، ١٥٠، ٢٠٠، ٢٥٠ كجم وحدة نتروجين/للفدان (في صورة يوريا ٤٦% نتروجين أو نترات الأمونيا ٣٣,٥% نتروجين)، أما السماد البوتاسى فقد تم إضافته بمعدل ٤٨ و٩٦ كجم بو٢أ/فدان (فى صورة سلفات بوتاسيوم ٤٨% بو٢أ). تم إضافة السماد النتروجينى على أربع دفعات هى: قبل الزراعة،٣٠ يوم من الزراعة، ٥٠ يوم من الزراعة و٧٠ يوم من الزراعة) أما السماد البوتاسى فقد تم إضافته على دفعتين هما: ٥٠ يوم من الزراعة و٧٠يوم من الزراعة. سجل العديد من قياسات النمو (ارتفاع النبات-عدد أوراق النبات-الوزن الطازج والجاف لأوراق النبات-الوزن الطازج والجاف للبصلة-الوزن الطازج والجاف الكلى للنبات)، المحصول الكلى للفدان (الأوراق+الأبصال) ومعامل التبصيل وبعض المكونات الكيماوية (محتوى الأوراق من الكلوروفيل الكلى والكاروتينويدات بالأضافة الى النتروجين،الفوسفور،البوتاسيوم،النتريت والنترات في كل من الأوراق والأبصال). **أوضحت النتائج المتحصل عليها مايلى:**

١- أظهرت النتائج أن صفات النمو -سالفة الذكر- قد تأثرت بإضافة السماد النتروجينى والبوتاسى، وكان لسماد اليوريا الأثر الأكبر على هذه الصفات مقارنة بنترات الأمونيا وكان لمعدل إضافة السماد النتروجينى (سواء اليوريا أو نترات

الأمونيا) تأثيراً معنوياً على هذه الصفات. وكما تلاحظ أن التفاعل مابين المصدر النتروجينى ومعدل الإضافة لم يكن له أى تأثير معنوى على معظم صفات النمو سالفة الذكر فى كلا موسمى الدراسة.

٢- أدى إضافة السماد البوتاسى بمعدل ٩٦ كجم بو٢أ/فدان إلى حدوث زيادة معنوية فى الوزن الطازج لأوراق النبات والوزن الطازج والجاف للبصلة وكذلك الوزن الطازج والجاف للنبات خلال موسمى الدراسة.

٣- سجل محصول نباتات الكرات الناتجة من معاملات التسميد باليوريا أعلى القيم مقارنة بمثيلتها الناتجة من النباتات المعاملة بسماد نترات الأمونيا على الرغم من عدم وجود فرق معنوى بينهما، ومع زيادة هذا المحصول بزيادة معدل السماد النتروجينى المضاف.

٤- أدت معاملات التسميد البوتاسى إلى حدوث زيادة معنوية فى محصول الكرات وكانت أعلى القيم ناتجة من النباتات بالمعدل الأعلى من السماد البوتاسى (٩٦ كجم بو٢أ/فدان) خلال موسمى الدراسة.

٥- لم يكن هناك أى تأثير معنوى للتفاعل بين عوامل الدراسة الثلاثة (مصدر ومعدل النتروجين ومعدل البوتاسيوم) على محصول الكرات فى كلا موسمى الدراسة.

٦- أعطت النباتات المعاملة باليوريا أقل قيم لتركيز النتريت والنترات فى الأوراق والأبصال مقارنة بمعاملة التسميد النتراتى. وكما لوحظ زيادة تركيز كلاهما بزيادة معدل النتروجين المضاف (بغض النظر عن المصدر المستخدم).

٧- حدوث نقص معنوي فى تركيز النتريت والنترات فى الأوراق والأبصال بزيادة تركيز البوتاسيوم (سواء مع اليوريا أو النترات) ومع زيادة هذا النقص فى حالة إضافة البوتاسيوم مع نترات الأمونيا مقارنة باليوريا.

وأخيراً، فإن النتائج المتحصل عليها من هذه الدراسة توضح أن إضافة اليوريا (كمصدر للسماد النتروجينى) بمعدل ٢٥٠كجم نتروجين/فدان والبوتاسيوم بمعدل ٩٦ كجم بو٢أ/فدان (فى صورة سلفات بوتاسيوم)، تعتبر أفضل جرعة تسميد لنباتات الكرات يمكن التوصية بها للحصول على أفضل نمو ومحصول وجودة للكرات.