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The Produtivity Of Potato Plants Affected By Urea Fertilizer As Foliar Spraying And Humic Acid Added With Irrigation Water

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ABSTRACT

Two field trials were carried out during the two experimental seasons of 2010/2011 and 2011/2012 at sandy soil to study the response of potato plants to the foliar spraying of urea, i.e. 2 % and 3 % and to the addition of humic acid with irrigation water at rates of 0, 10, 20 and 30 cm/l, and the important results are as following:

1. Urea as foliar spraying resulted the vigour potato plant, i.e. the tallest plants and that carried largest number, fresh and dry weight of leaves and stems. Moreover, the better plant growth was recorded with that plants received the higher urea level, i.e. 3%. Regarding total tuber yield as number and/or weights fluctuated within the two levels of urea, but generally, it could be summarized that, the application of urea within 2 – 3 % as foliar spraying, had an increase in tuber yield. Moreover, the obtained data revealed that, the content of protein, N, P, K, Mn, Zn, Fe and Cu recorded a superiority with using 3 % of urea.
2. Humic acid, generally resulted an enhancements in plant growth parameters, yield and its physical and/or chemical properties. Moreover, with increasing humic acid levels in irrigation water, the more vigour plant and heaviest tuber yield and its properties had gained. It could be concluded that, the best values of potato plants (growth, yield and quality) were obtained when adding 30 cm/l of humic acid for each one letter of irrigation water.
3. The interaction within the urea fertilizer as foliar application and mixing humic acid with irrigation water had no significant effect on potato plant growth, yield and its components.

Key words: Potato, Urea, Humic acid, Plant growth, Yield and Chemical properties.

Introduction

Potato is one of the major vegetable crops in Egypt. It is widely grown for local consumption and exportation, where the yield increase could be achieved by the appropriate horticultural practices. The farmers used to apply excess nitrogen of fertilizer that increase in a higher nitrate status in the underground water and increasing the crop running coast.

Chemical nitrogen fertilization plays an essential role in increasing potato yield and quality. The largest yields from field experiments were obtained with widely varying rates of N fertilizers, making the comparison, interpretation and extrapolation of the results difficult, since the soil, weather, cultivars and crop management differed. Although an apparently high demand of N for better production has been reported. Both excess and in-sufficient nitrogen application may cause either yield reduction or some physiological disorders and some pathological problems.

The application of urea fertilizer to leaves of plants has given response approximately equal to that of fertilizer applied to the soil. The uptake of urea is faster when it is sprayed on the leaves, but it is cheaper to apply it to the soil.

Urea (46 % N) is the most widespread nitrogen fertilizer in the world. Surface application of urea causes ammonia emission. Warm weather some soil properties (soil type, content and composition of organic matter, biological activity, high pH) and windy weather increase nitrogen losses to as much as 47 % (Watson, 2005).

The interest in foliar fertilizers arose due to the multiple advantages of foliar application methods such as rapid and efficient response to the plant needs, less product needed, and independence of soil conditions. It is also recognized that supplementary foliar fertilization during crop growth can improve the mineral status of plants and increase the crop yield (Kolota and Osinska, 2001). A high penetration rate is one of the pre-requisites for efficient foliar nutrition. Urea, due to its intrinsic characteristics such as small molecular size, non-ionic nature and high solubility, is usually taken up rapidly through the leaf cuticle. Urea can be supplied to plants through the foliage, facilitating optimal nitrogen management, which minimizes nitrogen losses to the environment. Most plants absorb foliar applied urea rapidly and hydrolyze the urea in the cytosol (Witte, *et al*., 2002).

The beneficial effects of foliar urea applications expressed as an increase in yield and an improvement of crop quality were reported in many vegetable species such as cabbage, onion, cucumber, squash (Kolota and Osinska, 2001).

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The absorption rate of mineral nutrients by aboveground plant parts considerably differs not only among plant species but also among varieties within the same species (Wojcik, 2001).

Humic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms (Halime *et al*., 2011). According to pervious investigations, humates seem to have a particular favourable effect on the nutrient supply. Therefore the application of humates was tested as an approach to improve both the nutrient balance and plant vitality (Boehme *et al*., 2005). Foliar sprays of these substances also promote growth, and increases yield and quality in a number of plant species; (Yildirim, 2007 and Karakurt *et al*., 2009). Likewise, humic substances have been shown to stimulate shoot and root growth and nutrient uptake of vegetable crops (Akinremi *et al*., 2000 and Cimrin and Yilmaz, 2005). Boehme *et al*., 2005 found that humic acid promotes the uptake of N, P, Fe and Cu of tomato and other plants.

The aim of this script is to study the response of potato plant for the application of urea as foliar spraying and humic acid as irrigation water addition on the growth, tuber yield of potato and its quality.

Materials And Methods

Field trails were carried out at a private farm in Sadaat city (60 km from Cairo city), Egypt, using potato (*Solanum tuberosum* L. cv. Cara). The potatoes tubers were grown on sandy soil and irrigated with drip irrigation system. Analyses of the soil are presented in Table (1).

The experimental design was a split plots with 3 replicates. The treatments were: applying urea (1) as foliar sprays at 2 rates, i.e. 2 % and 3% and (2) addition humic acid as mixed with irrigation water at rates of 0, 10, 20 and 30 cm/l. Where the urea application occupied the main plots, but humic acids rates randomly distributed within the sub-plots. Each sub-plot was 25.6 m^2 and contained 4 rows, 80 cm wide and 8 m long. Potato seeds (tubers) were planted manually on the last ten days of October during the two seasons of 2010 and 2011 using hand tool to dig holes at 30 cm intervals. Where nitrogen treatments in the form of urea (46.0 % N) were foliar sprayed 3 times, starting 45 day after planting and with 10 days intervals, whereas, the humic acids added 3 times as mixed with irrigation water, i.e. started 45 days after planting with 15 days intervals. For all experimental plot, single super-phosphate (15.5 % P_2O_5) was applied at once time before planting at the rate of 60 kg P_2O_5/fed. and potassium sulphate at the rate of 90 kg K_2O/fed. was added in two equal doses 30 and 45 days after planting. However, half of nitrogen recommendation 90 units/fed. as ammonium sulphate (20.6% N) of potatoes was added at two equal amounts at 30 and 45 days old. All agronomic practices were conducted according the recommendation of Egyptian Agricultural ministry.

Table 1: Physical and chemical properties of experimental soil.

Properties	Values	
Physical	1st season	2nd season.
Sand %	90	88
Silt %	5	4.8
Clay %	5	4.9
Texture	Sandy	Sandy
Available nutrient		
N %	Traces	Traces
P %	0.443	0.446
K %	0.575	0.580
Chemical properties (meq/L)		
pH	8.20	8.00
EC ds/m	1.50	1.49
$CaCO_3$%	5.50	5.61
Ca^{++}	2.65	2.67
Mg^{++}	2.40	2.50
Na^{+}	4.34	4.44
CO_3^{-}	Zero	Zero
HCO_3^{-}	3.85	3.78
Cl^{-}	53.00	52.17
SO_4^{-}	55.65	54.33

Five plants from each sub-experimental plot were randomly taken after 100 days from planting for measuring the vegetative growth parameters, i.e. plant height, number of leaves and/or stems, fresh and dry weight of whole potato plant and its different organs.

At harvesting time (120 days after planting) the tuber yield, i.e. numbers (per plant and/or sq.m.) and weights (as grams/plant and/or tons/fed.) as well as some physical properties of tuber such as fresh and/or dry weight of tubers as gram and/or tuber size as cm^3, all of these measurements were recorded. A ten tubers sample from each plot was taken randomly to evaluate chemical tubers quality such as total carbohydrate, protein, N, P and K contents according the method described by AOAC, 1990 for protein and Olsen and

Somers, 1982 (for N, P and K). However, Fe, Mn, Zn and Cu contents in dry matter of tubers were determined by Atomic absorption according to Rangana (1979).

Data from all trails were analyzed according to the procedure described by Snedecor and Cochran (1982). Comparisons among means of treatments were tested using the last significant differences (LSD) at 5% level of probability.

Results And Discussion

A. Plant growth characteristics:

Tables (2 and 3) show clearly that, potato plant growth characters greatly affected by urea and potassium humate application. However, urea as foliar spraying at 3 % level caused an increase in values of all plant growth parameters, i.e. plant height, number of leaves and /or stems/plant as well as total fresh and dry weight of whole plant and its different organs. These findings were true in both experimental seasons. Whereas, using urea at the higher level, i.e. 3 % recorded an increase in total fresh and dry weight of whole potato plant over that if plants sprayed by urea at 2 % level. This superiority amounted by 4.2 and 12.7 % respectively in 1st season, but amounted by 8.5 and 3.1 % in 2nd season. Generally, it could be concluded that, the taller potato plant which carried the more number and weights of leaves and stems all of these parameters was gained with that plants which foliar sprayed with urea at higher level, i.e. 3 %. Many authors studied the response of potato plant to nitrogen fertilizer particularly in the form of urea and recorded that, the plant growth parameters strongly associated with the increasing level application (Ismail, 2009; Amir *et al*., 2013 and Shahzad Jamaati *et al*., 2010). However, urea application was more benefit if used as foliar spraying, may be due to the speed absorption by leave tissues, consequently the vigour plant was resulted (Xu-Fuli *et al*., 2004 on cucumber; Yildirim *et al*., 2007 on broccoli and Abd El-Samad *et al*., 2011 on onion). Finely, the obtained results herein was completely similar with the previous investigation.

Concerning to the humic acids, the presented data of Tables (2 and 3) clearly demonstrated that, the application of humic acid compound at any rate resulted a superiority in plant growth characters if compared with that plants not received humic acid (control treatment). Moreover, with increasing the rates of humic addition up to 30 cm/l resulted in constant and gradually increase in values of vegetative plant growth. It means that, the most vigour potato plants, as expressed by the tallest plant height, which carried the highest average leaves and arial stems number and heaviest fresh and/or dry weight of the vegetative plants, all of those parameters were associated with that plants which supplied humic acids at 30 cm/l. This was clear in that data recorded in 1st season, but, it detected that, the application of humic acid at rate within 20 – 30 cm/l., resulted the best plant growth characters. Generally, it could be concluded that, humic acid application caused an enhancement in potato plant growth if compared with control, and by supplement it at rate within 20 – 30 cm/L., resulted the vigor plant growth. The statistical analysis of the collected data reveals that the differences within various humic acid levels were great enough to be significantly in both seasons, with except leaves number and leaves dry weight only in the 2nd season.

The increase aerial parts of potato plants, i.e. height of plant, numbers of leaves and stems, as well as fresh and dry weight of whole plants and its organs by addition humic acids through irrigation water might be due to the effect of humic acid which provides nutrients that involve in plant bioactivities and finally leads to growth induction (Abdel-Mawgood *et al*., 2007 and Taha, 2011). Moreover, humic acid increase the porosity of soil and improve growth of root system which leads to increase the shoot system (Garcia *et al*., 2008). The role of hamates in improving soil physical and chemical characteristics by reaction with soil minerals then improving watery, aerial soil characteristics and nutrient minerals absorption (Matarojev, 2002). Likewise, humic substances have been shown to stimulate shoot and root growth and nutrient uptake of vegetable crops (Akinremi, *et al*., 2000 and Cimrin and Yilmaz, 2005).

The interaction within the two factors of using urea as foliar spraying at 2 levels and humic acid application as addition with irrigation water regarding their effects on plant vegetative growth shown in Tables (2and 3). Whereas, as a general view, the recorded data shows that, under the two levels of urea, the plant growth values increased with addition humic acid, it means that, the heaviest fresh and dry weight of aerial vegetative parts were correlated with that, potato plants which supplied higher rate of urea, i.e 3 % as foliar spraying and highest level of humic acid, i.e. 30 cm/l., as added with irrigation water. The statistical analysis of the obtained data reveals that the differences within different interaction treatment were not significantly in both seasons with some exceptions.

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Table 2: Effect of the foliar application by urea and humic acid as adding to irrigation water on plant growth of potatoes grown in newly lands during 2010/2011 season.

Treatments		Plant height (cm)	Number / plant		Fresh weight (g)			Dry weight (g)		
Urea foliar	Humic conc. cm/L.		Leaves	Stems	Stems	Leaves	Total	Stems	Leaves	Total
Urea 2%	Control	51.33	60.00	7.00	111.33	248.33	359.67	14.53	18.20	32.73
	10	56.33	63.67	8.33	115.67	272.33	388.00	16.07	18.60	34.67
	20	57.00	66.00	9.67	122.00	286.67	408.67	16.30	22.17	38.47
	30	63.33	71.33	11.00	126.67	291.33	418.00	17.67	22.50	40.17
Mean		57.00	65.25	9.00	118.92	274.67	393.58	16.14	20.37	36.51
Urea 3%	Control	55.00	60.33	10.00	116.00	262.33	378.33	14.03	19.87	33.90
	10	60.67	66.00	11.33	120.33	283.67	404.00	15.80	23.07	38.87
	20	61.67	70.33	12.00	123.33	300.67	424.00	20.13	24.23	44.37
	30	73.67	72.67	13.00	132.33	302.33	434.67	22.67	24.77	47.43
Mean		62.75	67.33	11.58	123.00	287.25	410.25	18.16	22.98	41.14
Averages	Control	53.17	60.17	8.50	113.67	255.33	369.00	14.28	19.03	33.32
	10	58.50	64.83	9.83	118.00	278.00	396.00	15.93	20.83	36.77
	20	59.33	68.17	10.83	122.67	293.67	416.33	18.22	23.20	41.42
	30	68.50	72.00	12.00	129.50	296.83	426.33	20.17	23.63	43.80
L.S.D. at 5 %	Urea	5.41	1.29	2.35	3.53	9.32	12.79	0.62	2.02	2.27
	Humic conc.	3.43	2.19	1.60	4.94	8.93	10.55	0.82	1.61	1.89
	Interactions	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	1.16	N.S.	2.67

Table 3: Effect of the foliar application by urea and humic acid as adding to irrigation water on plant growth of potatoes grown in newly lands during 2011/2012 season.

Treatments		Plant height (cm)	Number / plant		Fresh weight (g)			Dry weight (g)		
Urea foliar	Humic conc. cm/L.		Leaves	Stems	Stems	Leaves	Total	Stems	Leaves	Total
Urea 2%	Control	42.67	35.67	5.00	133.33	133.67	267.00	15.23	16.40	31.63
	10	45.67	44.67	6.67	146.33	153.33	299.67	16.97	15.53	32.50
	20	53.33	38.67	6.67	152.33	151.33	303.67	19.43	17.30	36.73
	30	49.00	25.00	8.00	160.00	144.67	304.67	18.33	16.90	35.23
Mean		47.67	36.00	6.58	148.00	145.75	293.75	17.49	16.53	34.03
Urea 3%	Control	45.00	44.67	9.00	147.67	138.00	285.67	16.83	15.37	32.20
	10	49.67	36.67	9.67	165.00	159.00	324.00	17.90	17.13	35.03
	20	54.33	36.00	10.67	165.00	164.67	329.67	18.50	17.13	35.63
	30	56.67	53.33	12.33	175.67	160.00	335.67	20.93	16.53	37.47
Mean		51.42	42.67	10.42	163.33	155.42	318.75	18.54	16.54	35.08
Averages	Control	43.83	40.17	7.00	140.50	135.83	276.33	16.03	15.88	31.92
	10	47.67	40.67	8.17	155.67	156.17	311.83	17.43	16.33	33.77
	20	53.83	37.33	8.67	158.67	158.00	316.67	18.97	17.22	36.18
	30	52.83	39.17	10.17	167.83	152.33	320.17	19.63	16.72	36.35
L.S.D. at 5 %	Urea	N.S.	5.64	1.29	N.S.	5.57	22.83	N.S.	N.S.	N.S.
	Humic conc.	3.59	N.S.	1.09	7.66	7.40	11.97	1.34	N.S.	2.52
	Interactions	N.S.	8.65	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

B. Yield of tubers and its characteristics:

Total yield of potato tubers as numbers per plant and/or per square meter as well as weights as expressed by g/plant and/or tons/fed., all of them are responded by the interaction between foliar spraying by urea and the humic acid addition at different levels as shown in Tables (4 and 5) for seasons of 2010/2011 and 2011/2012. Whereas, from the obtained data, it clear to mention that, the total number of tubers and/or its weights fluctuated within the two experimental seasons as a result of using the two levels of urea. However, in 1st season, the better tuber yield (numbers and/or weights) was detected when the lower urea concentration used, but the opposite was happened in 2nd season. As a general it could be abstracted that, the recommended rate of urea as a foliar application may be within 2 – 3 %.

Regarding the characteristics of tuber yield, its clear from the presented data of Tables (4 and 5) that, the urea foliar application at higher level, i.e. 3 % resulted better average fresh and dry weight as well the bigger tubers than using the lower urea level. These results were similar in both seasons. So the statistical analysis of the obtained data reveals that the differences were significantly only in 2nd season for averages fresh and dry weight of tuber as well as the average tuber volume, but only for average tuber volume in 1st season.

Generally, it could be concluded that increase the rate of urea application from 2 to 3 % had a slow effect on tubers yield of potatoes in spite of its great effects on the vegetative plant growth characteristics. This indicate that, spraying urea at high rate may be affected on the leaves tissues consequently decreased the photosynthetic rate and the net assimilation rate, so that materials which stored in the underground organ (tubers).

From the obvious data, it is clear to mentioning that, these results are in good accordance with that data registered previously by other workers such as Xi-Fuli *et al*., 2004 on cucumber; Yildirim *et al*., 2007 on

broccoli. Moreover, many others, reported that, nitrogen fertilizer as soil dressing gained more yield if the rate increased (Abd El-Samad *et al*., 2011 on onion; Mohammad and Mohammadreza, 2012 and Amir *et al*., 2013 on potato and Shaheen *et al*., 2006 on Okra).

Humic acid (potassium humate) at different levels caused an increase in yield of potato tubers during the two experimental seasons as shown in Tables (4 and 5). Whereas, average tuber number and/or weight either for unit area or for plant recorded a great and constant increase with applying humic acid at rates up to 30 cm./L. However, the statistical analysis of the obtained data indicated that the differences within various humic acid concentrations were great enough to reach the 5 % of significant. These results were a good accordance with different tuber yield parameters as well as its physical properties, i.e. average fresh and dry weight of tuber as well as the tuber size, in both experiments.

Generally, it could be suggested that, the highest tubers number and the heaviest ones as g/plant and/or tons/fed., were associated with that potato plants received humic acid at rate of 30 cm/L., with irrigation water. The increase in yield characteristics might be due to significant effect of humic acid on shoot system further than increase in tuber number/plant and tuber weight which reflect positively on increase of plant yield and total yield. The reasons behind these results might also be due to that the added humic acid is characterized by its high content of nutrient elements as well as providing nutrient base that increase the activity of microorganisms. Taha, (2011) reported that humic acid characterized by improving plant growth directly or indirectly it act as biostimulant induced hormonal activity of plant releasing different auxin types which in regulating plant growth and environmental responses.

Hunic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms (Halime *et al*., 2011). According to previous investigations humates seem to have a particular favourable effect on the nutrient supply. Therefore the application of humates was tested as an approach to improve both the nutrient balance and plant vitality (Boehme *et al*., 2005). Foliar sprays of these substances also promote growth, and increases yield and quality in a number of plant species. Yildirim, 2007; Karakurt *et al*., 2009) at least partially through increasing nutrient uptake serving as a source of mineral plant nutrients and regulator of their release (Atiyeh *et al*., 2002).

Also, Tables (4 and 5) clearly showed that, the interaction within the two studied factors, defected that, the tubers number weight and sizes during the two experimental seasons had no significant response. In spite the no significant response in most cases, but generally, it could be concluded that, adding humic acid caused an enhancement in number and weight of tubers under the two levels of urea spraying. Moreover, with increasing humic acid concentration resulted more increase in tubers properties. Finely, the highest tubers number, weight and size were recorded when urea sprayed at higher level, i.e. 3 % and irrigated with water contained humic acid at highest rate, i.e. 30 cm/l.

Table 4: Effect of the foliar application by urea and humic acid as adding to irrigation water on total tubers yield and its some physical properties of potato grown in newly lands during 2010/2011 season.

Treatments		No. of tubers		Wt. of tubers		Wt. of tuber g		Volume cm^3 / tuber
Urea foliar	Humic conc. cm/l.	Plant	m^2	Plant g	Ton/fed.	Fresh	Dry	
Urea 2%	Control	8.77	35.00	933.33	12.61	105.00	13.33	124.67
	10	11.30	43.67	1121.33	15.17	112.67	14.50	153.33
	20	11.73	46.33	1357.67	19.42	122.00	18.67	158.00
	30	12.27	50.33	1463.33	20.91	121.67	19.30	165.00
Mean		11.02	43.83	1218.92	17.03	115.33	16.45	150.25
Urea 3%	Control	9.47	34.00	806.67	11.55	104.33	16.20	133.33
	10	10.47	41.67	1130.00	15.67	104.00	17.73	156.33
	20	10.80	42.00	1150.00	15.81	110.00	19.73	172.33
	30	11.40	45.33	1327.67	18.67	117.00	20.57	181.67
Mean		10.53	40.75	1103.58	15.43	108.83	18.56	160.92
Averages	Control	9.12	34.50	870.00	12.08	104.67	14.77	129.00
	10	10.88	42.67	1125.67	15.42	108.33	16.12	154.83
	20	11.27	44.17	1253.83	17.62	116.00	19.20	165.17
	30	11.83	47.83	1395.50	19.79	119.33	19.93	173.33
L.S.D. at 5 %	Urea	N.S.	2.18	41.97	0.64	N.S.	N.S.	8.20
	Humic conc.	0.71	2.67	24.52	0.57	5.00	1.36	6.73
	Interactions	N.S.	N.S.	34.67	0.81	N.S.	N.S.	N.S.

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Table 5: Effect of the foliar application by urea and humic acid as adding to irrigation water on total tubers yield and its some physical properties of potato grown in newly lands during 2011/2012 season.

Treatments		No. of tubers		Wt. of tubers		Wt. of tuber g		Volume cm^3 / tuber
Urea foliar	Humic conc. cm/L.	Plant	m^2	Plant g	Ton/fed.	Fresh	Dry	
Urea 2%	Control	9.40	36.33	971.00	10.43	105.67	15.83	105.00
	10	10.60	41.33	1083.67	12.04	106.33	17.90	114.33
	20	11.40	45.67	1391.00	12.22	112.33	19.33	121.00
	30	11.93	46.67	1493.33	12.76	121.00	21.17	124.33
Mean		9.40	36.33	971.00	10.43	105.67	15.83	105.00
Urea 3%	Control	10.10	35.00	948.67	10.36	104.33	17.20	123.00
	10	10.81	44.00	1143.33	12.32	111.00	19.43	136.67
	20	11.23	43.33	1200.00	12.72	122.67	22.33	135.00
	30	12.67	47.67	1333.67	13.95	130.33	21.83	142.33
Mean		11.20	42.50	1156.42	12.34	117.08	20.20	134.25
Averages	Control	9.75	35.67	959.83	10.39	105.00	16.52	114.00
	10	10.71	42.67	1113.50	12.18	108.67	18.67	125.50
	20	11.32	44.50	1295.50	12.47	117.50	20.83	128.00
	30	12.30	47.17	1413.50	13.36	125.67	21.50	133.33
L.S.D. at 5 %	Urea	N.S.	N.S.	62.36	0.08	2.85	1.55	3.74
	Humic conc.	1.09	2.94	57.01	0.75	4.93	1.78	4.95
	Interactions	N.S.	N.S.	80.63	N.S.	N.S.	N.S.	N.S.

C. Nutritional values of tuber yield:

The data presented on Tables (6 and 7) showed clearly, that the protein, N, P, K, Mn, Zn, Fe and Cu contents of potato tuber tissues affected by the application of urea as foliar nitrogen fertilizer and humic acid as added within irrigation water. Whereas, increasing rate of urea form 2 % up to 3% had a little increase effect on nutritional values particularly protein (3 %), N (4 %) and Fe (1.4 %) content. However, these increases for other nutritional values amounted by 14.8 % (P), 28.5 % (K), 23.1 % (Mn), 23.1 % (Zn) and 24.8 % (Cu).

Generally, it could be concluded that, urea using as foliar spraying on potato plants caused an increase in nutritional values of potato tubers.

Increasing the urea application gained an increase in the nutrient elements in plant tissues. Moreover, the foliar spraying of urea was more better than soils dressing, due to its speed absorption by leaves tissue. Consequently, the plant metabolism processed was more active, so absorbed more minerals. The before studies of Abd El-Badea *et al*., 2011, Davoud *et al*., 2009 on potatoes, and Abd El-Samad *et al*., 2011 on onion, Abd El-al, 2009 on sweet pepper, Xu-Fuli *et al*., 2004 on cucumber, all of their results are in good similar of that recorded herein.

Adding humic acid within irrigation water for potato plants caused an enhancement in nutritional values of potato tubers if compared with that plant no received humic acid. Moreover, with increasing the addition rate of humic acid, gradually and constant increase in protein, N, P, K, Mn, Zn, Fe and Cu were happened. Shortly, it could be stated that, the best chemical quality of potato tubers (high nutritional values) were associated with that plants received the high level of humic acid, i.e. 30 cm/l. By other mean, these superiority of nutritional values over the control plants (no humic acid) amounted by 18.8, 18.4, 54.2, 26.5, 29.7, 20.0, 19.0 and 24.8 % respectively, for protein, N, P, K, Mn, Zn, Fe and Cu. It could be concluded that, Humates can stimulate the uptake of macro and microelements in potato plants.

Humic acid affected on plant growth and its physiological activities, including humic acid which promote plant growth and induce soil microorganisms like bacteria and fungi and provide carbon as a source for organisms. Humic acid as well as acting as chelating good material, and reason the lake of mineral nutrient and losing them by leaching and also more many nutrient available in soil such as phosphorus, calcium and trace elements (Leonard, 2008).

Moreover, Taha, (2011) reported that, humic acid is characterized by its high content of nutrient elements as well as providing nutrient base that increase the absorption of elements by rooting system, consequently increasing the concentration of elements in plant organs. Also, the same author added that Humates can stimulate the uptake of microelements, by create a positive effect on uptake of N, P, Fe, Cu, Mn ad Zn) of some vegetable plants, consequently increased their concentration in plant organs.

Table 6: Effect of the foliar application by urea and humic acid as adding to irrigation water on chemical contents of potatoes grown in newly lands during 2010/2011 season.

Treatments		%				ppm			
Urea foliar	Humic conc. cm/l.	Protein	N	P	K	Fe	Mn	Zn	Cu
Urea 2%	Control	8.43	1.35	0.22	0.44	261	33	36	9.7
	10	8.81	1.41	0.23	0.42	275	31	35	10.3
	20	9.00	1.44	0.31	0.51	277	37	41	10.7
	30	10.10	1.61	0.35	0.53	300	41	46	13.0
Mean		9.10	1.45	0.27	0.49	278	39	39	10.9
Urea 3%	Control	8.56	1.37	0.26	0.55	255	41	44	12.2
	10	9.00	1.44	0.27	0.59	271	45	47	13.6
	20	10.00	1.60	0.31	0.66	285	51	49	14.1
	30	10.10	1.61	0.40	0.71	315	56	51	14.3
Mean		9.40	1.51	0.31	0.63	282	48	48	13.6
Averages	Control	8.50	1.36	0.24	0.49	258	37	40	10.9
	10	8.87	1.42	0.25	0.53	273	38	41	11.9
	20	9.50	1.52	0.31	0.58	281	44	45	12.4
	30	10.10	1.61	0.37	0.62	307	48	48	13.6

Table 7: Effect of the foliar application by urea and humic acid as adding to irrigation water on chemical contents of potatoes grown in newly lands during 2011/2012 season.

Treatments		%				ppm			
Urea foliar	Humic conc. cm/L.	Protein	N	P	K	Fe	Mn	Zn	Cu
Urea 2%	Control	7.21	1.31	0.19	0.38	251	25	25	7.5
	10	7.33	1.36	0.23	0.41	259	29	31	7.9
	20	7.80	1.37	0.25	0.42	266	30	33	8.3
	30	8.50	1.55	0.31	0.46	301	31	36	8.4
Mean		**7.71**	1.39	0.24	0.42	269	29	31	8.0
Urea 3%	Control	7.66	1.34	0.33	0.46	260	29	41	8.1
	10	7.91	1.45	0.34	0.49	266	33	45	8.3
	20	8.30	1.51	0.36	0.51	271	34	48	8.5
	30	8.50	1.66	0.39	0.56	275	44	51	10.1
Mean		8.10	1.40	0.24	0.49	268	35	46	8.7
Averages	Control	7.43	1.32	0.26	0.42	255	27	33	8.7
	10	7.62	1.40	0.28	0.45	262	31	38	8.1
	20	8.15	1.44	0.30	0.46	266	32	40	8.4
	30	8.30	1.60	0.35	0.51	288	37	43	9.2

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