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Increasing Nitrogen Efficiency by Humic Acid Soil Application to Squash Plants (*Cucurbita pepo* L.) Grown in Newly Reclaimed Saline Soil

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TWO FILED seasons were conducted during the summer seasons of 2010 and 2011 in the Experimental Farm at Demo, Faculty of Agriculture, Fayoum University, to increase nitrogen efficiency (ammonium nitrate 33.5% N, 150, 200, 250 and 300 kg fed^{-1}) under three concentrations of humic acid as water solution 0.5, 1.0 and 1.5gL^{-1}, in addition to the untreated as control to squash plants (*Cucurbita pepo* L.) (cv. Amjjed hybrid) grown in newly reclaimed saline soil..

In comparison with control, all other rates significantly increased vegetative growth plant characters (*i.e.* number of leaves plant^{-1}, stem length, total leaf area plant^{-1}, leaf area leaf^{-1} and also, leaves, stem and canopy dry weight plant^{-1}) as well as fruit yield and its components (*i.e.* number of fruits plant^{-1}, yield plant^{-1} and total yield of fruits fed^{-1}) except average of fruit weight. In addition, the concentrations of N, P and K % in leaves were increased, and Na and Cl were decreased. The same results were obtained with all nitrogen fertilizer rates, 200, 250 and 300 kg ammonium nitrate fed^{-1} as compared to the 150 kg fed^{-1} with some exceptions, P% was not affected and K% was decreased with increasing the rate of nitrogen.

In view of the above mentioned results, it has been concluded that the efficiency of nitrogen fertilization increased with soil application of humic acid reflected on the growth and chemical composition and yield of squash (cv. Amjjed hybrid), and was the best treatment: the water solution of humic acid (1.5gL^{-1}), with nitrogen fertilizer (250 kg) ammonium nitrate fed^{-1} where given a significant increase of total squash fruits yield fed^{-1} grown in newly reclaimed saline soil.

Keywords: Squash (*Cucurbita pepo* L.), Humic acid, Nitrogen fertilizer, Salinity, Vegetative growth, Yield, Chemical composition.

Squash is widely cultivated on newly-reclaimed soils in Egypt. Most newly-reclaimed soils are affected by salinity, low fertility and poor soil structure. The sustainability of crop production is primarily a function of various environmental stress factors, including salinity (Kumar *et al.*, 2009), which is associated with the fertility status of the soil (Sogbedi *et al.*, 2006). Soil fertility is adversely affected by salinity, which has emerged as one of the most serious factors that limits plant growth and productivity, and consuming the soil health (Turkan and Demiral, 2009). The loss in plant productivity due to salinity arises as a consequence of an imbalance in ion and nutrient concentrations, and osmotic effects (Ashraf, 2009), resulting in the over-production of reactive oxygen species (ROS) compared to their levels in aerobic metabolic processes in chloroplasts, mitochondria, and peroxisomes under normal physiological conditions. The over-production of ROS causes oxidative damage to lipids, proteins and nucleic acids and affects the properties of cell membranes (Ahmad *et al.*, 2008). Salt stress affects plant physiology, both at the whole plant and cellular levels, through osmotic and ionic stress. Salinity generates a ‘physiological drought’ or osmotic stress by affecting the water relations of the plant (Munns, 2002). Photosynthesis is one of the most severely affected processes during salinity stress (Sudhir and Murthy, 2004). All these and other altered processes lead to poor plant growth and a subsequent loss in productivity. However, plants are well-equipped with anti-oxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), peroxidase (POX) and ascorbate peroxidase (APX), and non-enzymatic low molecular anti-oxidant molecules such as ascorbic acid, glutathione, carotenoids and tocopherols to counter any oxidative stress and to protect the plants from oxidative damages (Apel and Hirt, 2004).

Over the last few decades, in parallel with breeding and biotechnological strategies to improve plant tolerance to salinity (Maggio *et al.*, 2003), several techniques have been proposed to ameliorate the adverse effects of saline environments on plant performance. These include seed or seedling priming (Azooz, 2009) applications of stress metabolites that could be recognized and/or integrated by plants as components of stress-induced adaptation responses (Ashraf and Foolad, 2007), and foliar applications of osmo-protective molecules such as anti-oxidants. Most have been shown to have beneficial effects on plants exposed to salt stress (Ali *et al.*, 2007, Rady, 2011a). Mineral and organic fertilizers, added singly or in combination, are an important means of plant nutrition, particularly in saline soils. Attention has therefore focused on combinations of mineral and organic fertilizers such as humic acid (HA), as a technique to overcome the adverse effects of soil salinity on plants.

Humic substances are commercial products that contain elements which improve soil fertility, increase the availability of nutrient elements and, consequently have positively effects on plant growth and yield. In addition, they reduce the negative effects of chemical fertilizers and removes NO_2^- and NO_3^- ions from the soil (Rady, 2011b). Humic substances can supply grown plants with nutrients, make the soil more fertile and productive, and increase its water-holding capacity. Therefore, humic substances are useful for reclaimed, saline soils because they help plants to resist salinity and drought, help to establish a desirable environment for the development of microorganisms, and stimulate seed germination (Salman *et al.*, 2005). Many authors reported significantly improved mineral contents, fruit yields, and fruit quality in some plants species due to the application of humic acid (HA), with or without mineral fertilizer. Further, under different soil conditions, the application of humic substances has been reported to improve plant growth and chemical composition, which are positively reflected in higher crop yields and quality (Selim *et al.*, 2009, Mahmoud & Hafez, 2010, Hanafy *et al.*, 2010 and Osman & Rady, 2012).

Humic substances (humic and fulvic acids) constitute 65-70% of the organic matter in soils. These compounds are the products of decomposition of plant tissues and are predominantly derived from lignified cell walls. The major functional groups of humic acids include carboxyl, phenolic hydroxyl, alcoholic hydroxyl, ketone and quinoid (Russo & Berlyn, 1990). The most beneficial effects of humic substances on plant growth may be related to their positive effects (*i.e.* increase of fertilizer efficiency and/or reducing soil compaction) on growing media (Nardi *et al.*, 2002). In addition, the mechanism of humic acid activity in promoting plant growth has been proposed to be increasing cell membrane permeability, oxygen uptake, respiration and photosynthesis, nutrient uptake and root cell elongation (Russo & Berlyn, 1990, Böhme & Thi Lua, 1997 and Nardi *et al.*, 2002). The effects of humic acid on tomato seedling growth in some growing media were investigated (Loffredo *et al.*, 1997, Pertuit *et al.*, 2001, Atiyeh *et al.*, 2002, Nardi *et al.*, 2002 and Osman & Rady, 2012).

There is a general agreement, that among all nutrient amendments applied to soil, nitrogen fertilizer was found to be the more effecting one in increasing growth and productivity of the crop plants. While summer squash is considered a heavy feeder, it requires low nitrogen for good fruit development. Increasing the rate of nitrogen (N) fertilization generally increases cucurbit yield. The current preplanting recommendation for N application in summer squash is 150 Ib/ acre and petiole sap NO_3^- N sufficiency ranges between 800 and 900 ppm at first harvest (Olson and Kurts, 1982). Plants supplied with 150 kg N fed^{-1} produced heavier dry weight of the aerial vegetative parts, more number and larger area of leaves plant^{-1} than those supplied with lower N levels (Tolba, 2005).

Since salinity is considered a global problem and a potential threat to agricultural productivity, this work focused mainly on ways to possibility of increasing the efficiency of nitrogen fertilization under different levels of humic acid to squash (*Cucurbita pepo* L.) plants grown in newly reclaimed saline soil (EC = 8.07 – 8.04 dS m^{-1}) in two experimental seasons (2010 and 2011) using N and/or HA to elucidate their potential to modulate responses to salinity stress.

Materials and Methods

Two field experiments were conducted during the summer seasons of 2010 and 2011 at the Agriculture Experimental Station, Faculty of Agriculture, Fayoum University, to evaluate the response of squash plant (*Cucurbita pepo* L.) to application of four rates of ammonium nitrate fertilizer (33.5% N), 150, 200, 250 and 300 kgfed^{-1} (The 150 level was used as control treatment), and three concentrations of humic acid (90.3%) as water solution 0.5, 1.0 and 1.5 gL^{-1} besides the untreated 0.0 level as control.

Soil samples (0.25 cm depth) were taken just before starting each experiment. Cores from different replications were bulked and the samples were analyzed. Physical and chemical analysis was performed by the College of Agriculture Soil Testing in Laboratory according to the standard procedures (Wilde *et al.*, 1985), and the obtained results are presented in Table 1.

TABLE 1. Some physical and chemical characteristics of the experimental site in 2010 and 2011 seasons.

Properties	**2010**	**2011**
Physical properties		
Clay (%)	25.8	24.8
Silt (%)	21.9	20.5
Fine sand (%)	52.3	54.7
Soil texture	Sandy clay loam	Sandy clay loam
Chemical properties		
pH	8.39	8.34
ECe (dsm^{-1})	8.07	8.04
Organic matter (%)	1.14	1.20
Ca CO_3 (%)	12.18	12.49
N (%)	0.06	0.07
Soluble ions (m mole L^{-1})		
Ca^{++}	19.87	18.63
Mg^{++}	8.64	9.22
Na^{+}	50.93	51.82
K^{+}	0.71	0.60
CO_3^{--}	0.00	0.00
HCO_3^{-}	2.99	3.10
Cl^{-}	37.30	36.50
SO_4^{--}	41.30	41.90
Available elements(mg kg^{-1} soil):		
N	35.45	35.89
P	4.63	4.96
K	200.04	198.99
Fe	4.87	5.15
Mn	0.77	0.88
Zn	0.65	0.71
Cu	0.49	0.46

Field experiments

Imported squash hybrid seeds cv. Amjjed (produced by Seminis-Peto seed Company, USA) were hand sown in the field on March 15th, 2010 and March 12th, 2011. Each plot consisted of four rows, 4 meters long with one guard row on each side to prevent border effect. The between row spacing was 70 cm and the within row spacing was 40 cm. The experimental unit area was 11.2 m^2.

The experimental layout was a factorial experiment in a completely randomized blocks design with four replications. Ammonium nitrate fertilizer was side banded at two equal portions, 3 and 5 weeks after seed sowing.

Water solution of humic acid was applied as soil application beside plant holes three times after 15, 25 and 35 days from seed sowing (35 ml $hole^{-1}$). All plots received uniform dose of calcium super phosphate (15.5% P_2O_5) at 200 kg fed^{-1} during land preparation, while an identical rate of K fertilizer in the form of potassium sulphate (48% K_2O) at 100 kg fed^{-1} was side banded at two equal portions, 3 and 6 weeks from sowing. Recommended agro-management practices were performed for the commercial production of squash (according to Egyptian ministry of agriculture).

Plant sampling

In each experimental unit, plants from the two outer rows were randomly chosen for morphological characters and chemical composition, while the two middle rows were chosen to determine fruits yield and its components.

Data Recorded

Morphological characters

Forty five days after seed sowing, four plants were randomly chosen. Plants were carefully cut off at the ground level and immediately carried to the laboratory where they were separated into leaf-blades and stems including leaf-petioles. The following morphological characters were measured:

- Number of leaves $plant^{-1}$ was counted.
- Stem length (cm) was measured starting from the ground level to the epical meristem of the stem.
- Total leaf area $plant^{-1}$ (cm^2) using leaf area-leaf weight relationship as illustrated by Nassar (1986).
- Leaf area $leaf^{-1}$ was calculated using the following formula:
- Leaf area $leaf^{-1}$ = $\frac{\text{Leaves area plant}^{-1}}{\text{Number of leaves plant}^{-1}}$
- Leaves and stems dry weights $plant^{-1}$ were gained by drying at 70°C in a forced-air oven till the constant weight.
- Canopy dry weight $plant^{-1}$ was determined using oven dried leaves and stems by summation.

Fruits yield and its components

In each experimental unit, four plants randomly chosen were marked and left to grow till the fruits reached the marketable stage. The fruits were picked from each single plant separately and the following data were recorded:

- Number of fruits $plant^{-1}$, average number of harvested fruits through the entire harvesting period.

- Yield plant^{-1}, average weight of fruits during the whole harvesting period.
- Fruit weight average, calculated by dividing weight of fruits plant^{-1} by number of fruits plant^{-1}.
- Total yield fed^{-1}, recorded as the total weight of harvested fruits from all plants of the three middle rows, and then theoretically calculated as tones fed^{-1}.

Chemical Composition

Leaf samples for chemical determination, from four randomly selected plants in each experimental unit, after 45 days of seed sowing, were collected, washed with tap water, rinsed three times with distilled water and dried at 70°C in a forced-air oven till constant weight. The dried samples of leaves were finely grounded and weights of 0.2 g of the fine powder were digested using a mixture of sulphoric and perchloric acids. The following determinations were performed:

- Leaf N% was estimated using the Microkjeldahal apparatus as described in A.O.A.C. (1995).
- Leaf P% was colourimetrically estimated according to the Stannous molybdate chloride method as illustrated in A. O. A. C (1995).
- Leaf K and Na% were photometrically measured using Flam photometer as mentioned by Wilde *et al.* (1985).
- Leaf Cl% was determined using atomic absorption spectrophotometer apparatus as outlined by Higinbotham *et al.* (1967).

Statistical analysis

Appropriate analysis of variance was performed on results of each experiment. Comparisons among means of different treatments were performed using the Least Significant Difference procedure (L.S.D.) at P = 0.05 level as illustrated by Snedecor and Cochran (1980).

Results

Morphological Characters

Number of leaves plant^{-1}

Humic acid application with any level led to a significant increase in number of leaves plant^{-1} comparing to control, whereas, no significant increases were detected between the levels 0.5, 1.0 and 1.5 gL^{-1} and the trend was the same in both seasons (Table 2).

Increasing nitrogen fertilizer level from 150 to 200 kg fed^{-1} increased number of leaves plant^{-1}, but this effect was not significant when nitrogen fertilizer dose exceeded 200 kg fed^{-1}, in both seasons.

The interaction effect of the two studied factors on number of leaves plant^{-1} was no significant, in both seasons.

Stem length

The analysis of variance on data of stem length proved, clearly, that the general effects of the two studied factors (humic acid and nitrogen fertilizer) were significant and the trend was similar in both seasons (Table 2).

The comparisons among humic acid concentrations, obviously, indicated that increasing the concentration of humic acid from 0.0 to 0.5 gL^{-1} and from 0.5 to 1.0 gL^{-1} markedly increased stem length but, increasing the concentration from 1.0 to 1.5 gL^{-1}, the increment did not reach the level of significance and the trend was the same in 2010 and 2011 seasons.

The comparisons among nitrogen treatments showed that increasing nitrogen rate from 150 kg fed^{-1} (control) to 200 kg fed^{-1} and from 200 to 250 kg fed^{-1} significantly and progressively increased stem length. However, further increase of nitrogen fertilizer rate to 300 kg fed^{-1} did not promote stem length to go forward in both seasons.

The effect of interaction between the two studied factors on stem length was true, in both experimental seasons. The highest mean value of stem length was recorded when humic acid at 1.5 gL^{-1} and nitrogen fertilizer level at 250 kg ammonium nitrate fed^{-1}, combined together.

Total leaf area plant^{-1}

Progressive increases in total leaf area $plant^{-1}$ occurred due to application of humic acid up to 1.0 gL^{-1}, in both experimental seasons. But, increasing humic acid concentration to 1.5 gL^{-1} did not differ significantly than the 1.0 gL^{-1}.

Comparisons among the various nitrogen fertilizer rates displayed that, increasing nitrogen fertilizer doses from 150 up to 200 kg fed^{-1} was responsible for the statistically increments in total leaf area $plant^{-1}$, in both seasons. While, raising the level of nitrogen fertilizer from 200 to 300 kg fed^{-1}, did not increase total leaf area significantly.

The interaction effect between the different concentrations of humic acid and varying levels of nitrogen fertilizer on total leaf area $plant^{-1}$, in both seasons, was not significant.

Leaf area leaf^{-1}

Data in Table 2 showed that application of 0.5 gL^{-1} humic acid did not revealed significant effect on leaf area $leaf^{-1}$ while, the application of humic acid at concentrations of 1.0 and 1.5 gL^{-1} was pioneer and significantly recorded higher mean values of leaf area $leaf^{-1}$ comparing to control 0.0 gL^{-1}, in 2010 and 2011 seasons. Nevertheless, difference in leaf area $leaf^{-1}$ between the concentrations of 1.0 and 1.5 gL^{-1} was at par.

Data in Table 2 showed that nitrogen at 200 kg fed^{-1} had no marked effect on leaf area $leaf^{-1}$ while, the application of nitrogen at 250 and 300 kg fed^{-1} markedly increased leaf area $leaf^{-1}$ comparing to the control (150 kg fed^{-1}) and the data also, revealed no significant difference between the two levels and the trend was the same in both seasons of the experiment.

The combined influence of humic acid concentrations and nitrogen fertilizer levels on leaf area $leaf^{-1}$ was nonsignificant, in both seasons.

TABLE 2. Influence of different soil application rates of humic acid and nitrogen fertilizer on morphological characters of squash plant grown under reclaimed saline soil conditions during 2010 and 2011.

Humic acid, H (g L^{-1})	Season									
	2010					2011				
	Ammonium nitrite, N (kg fed^{-1})									
	150	200	250	300	Mean	150	200	250	300	Mean
	Number of leaves plant^{-1}									
0.0	6.5	7.5	7.4	7.6	**7.2**	6.6	7.7	7.6	7.8	**7.4**
0.5	8.1	9.2	9.1	9.3	**8.9**	8.4	9.5	9.3	9.5	**9.2**
1.0	8.9	9.5	9.7	9.3	**9.3**	9.1	9.9	10.0	9.6	**9.6**
1.5	8.5	9.3	9.2	9.0	**9.0**	8.8	9.6	9.6	9.3	**9.3**
Mean	**8.0**	**8.9**	**8.9**	**8.8**		**8.2**	**9.1**	**9.1**	**9.1**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	0.7		0.7	n.s.		0.8		0.7	n.s.	
	Stem length (cm)									
0.0	2.8	3.8	4.0	4.2	**3.8**	2.9	4.0	4.2	4.5	**3.9**
0.5	3.3	4.5	4.8	4.8	**4.4**	3.5	4.7	5.0	5.0	**4.6**
1.0	4.2	5.2	5.5	5.3	**5.0**	4.3	5.4	5.7	5.5	**5.2**
1.5	4.7	5.0	5.7	5.1	**5.1**	4.8	5.2	5.9	5.3	**5.3**
Mean	**3.8**	**4.6**	**5.0**	**4.9**		**3.9**	**4.8**	**5.2**	**5.1**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	0.4		0.4	1.0		0.4		0.4	1.1	
	Total leaf area plant^{-1} (cm^2)									
0.0	1181	1475	1645	1707	**1502**	1226	1531	1716	1770	**1561**
0.5	1509	1859	2007	2047	**1856**	1570	1933	2093	2128	**1931**
1.0	1846	2150	2196	2220	**2103**	1920	2238	2291	2308	**2189**
1.5	1973	2111	2156	2053	**2073**	2051	2194	2248	2135	**2157**
Mean	**1627**	**1899**	**2001**	**2007**		**1692**	**1974**	**2087**	**2085**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	143		143	n.s.		150		150	n.s.	
	Leaf area leaf^{-1} (cm^2)									
0.0	183	199	224	224	**207**	185	201	228	226	**210**
0.5	186	203	223	221	**208**	188	205	226	224	**211**
1.0	212	226	227	239	**226**	216	227	230	239	**228**
1.5	234	227	237	229	**232**	234	229	237	229	**232**
Mean	**204**	**214**	**228**	**228**		**206**	**216**	**230**	**229**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	19		18	n.s.		19		17	n.s.	

Leaves, stem and canopy dry weight

Leaves dry weight plant^{-1}

Data illustrated in Table 3 reflected that all humic acid concentrations increased leaves dry weight plant^{-1} compared to control (0.0 gL^{-1}). The differences between 0.0 and 0.5 gL^{-1} and between 0.5 and 1.0 gL^{-1} were significant, whereas, the increment in dry weight of leaves plant^{-1} between 1.0 and 1.5 gL^{-1} did not reach the level of significance and the trend was the same in 2010 and 2011 seasons..

TABLE 3. Influence of different soil application rates of humic acid and nitrogen fertilizer on leaves, stem and canopy dry weight of squash plant grown under reclaimed saline soil conditions during 2010 and 2011.

Humic acid, H (g L^{-1})	Season									
	2010					2011				
	Ammonium nitrite, N (kg fed^{-1})									
	150	200	250	300	Mean	150	200	250	300	Mean
	Leaves dry weight plant^{-1} (g)									
0.0	10.03	12.13	15.13	15.57	**13.22**	10.42	12.44	15.62	16.17	**13.66**
0.5	14.07	15.90	16.50	17.00	**15.87**	14.63	16.35	17.21	17.62	**16.45**
1.0	17.27	18.30	18.90	18.33	**18.20**	17.96	18.90	19.64	19.22	**18.93**
1.5	18.00	18.83	18.20	17.93	**18.24**	18.71	19.43	18.98	18.66	**18.94**
Mean	**14.84**	**16.29**	**17.18**	**17.21**		**15.43**	**16.78**	**17.86**	**17.92**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	1.11		1.11	2.23		1.10		1.10	2.21	
	Stem dry weight plant^{-1} (g)									
0.0	2.62	4.00	4.62	4.85	**4.02**	2.70	4.12	4.79	5.00	**4.15**
0.5	4.24	5.07	5.13	5.13	**4.89**	4.31	5.23	5.33	5.34	**5.05**
1.0	5.11	5.95	6.38	6.26	**5.93**	5.31	6.20	6.63	6.51	**6.16**
1.5	6.01	6.32	6.12	5.64	**6.03**	6.24	6.57	6.38	5.86	**6.27**
Mean	**4.50**	**5.34**	**5.56**	**5.47**		**4.64**	**5.53**	**5.78**	**5.68**	
L.S.D at 5%	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
	0.64		0.64	1.30		0.65		0.65	1.32	
	Canopy dry weight plant^{-1} (g)									
0.0	12.66	16.13	19.75	20.41	**17.24**	13.13	16.56	20.40	21.17	**17.81**
0.5	18.30	20.97	21.63	22.13	**20.76**	18.94	21.59	22.54	22.96	**21.51**
1.0	22.38	24.25	25.28	24.60	**24.13**	23.28	25.10	26.27	25.73	**25.09**
1.5	24.01	25.16	24.32	23.58	**24.27**	24.95	26.00	25.36	24.52	**25.21**
Mean	**19.34**	**21.63**	**22.75**	**22.68**		**20.07**	**22.31**	**23.64**	**23.59**	
L.S.D	**N**		**H**	**N × H**		**N**		**H**	**N × H**	
at 5%	1.26		1.26	2.53		1.28		1.28	2.56	

Application of nitrogen fertilizer showed that increasing the level from 150 to 200 kg fed^{-1} increased leaves dry weight plant^{-1} markedly, whereas, the increments in leaves dry weight plant^{-1} between 200 and 250 kg fed^{-1} and between 250 and 300 kg fed^{-1} were progressive but not significant and the trend was the same in both seasons.

The combined soil application of humic acid at 1.0 g L^{-1} together with 250 kg fed^{-1} nitrogen fertilizer, significantly achieved the heaviest dry weight of leaves, in both summer seasons of 2010 and 2011.

Stem dry weight plant^{-1}

Progressive significant increases in stem dry weight $plant^{-1}$ were performed due to increases in humic acid concentrations up to 1.0 gL^{-1}, in both seasons. Raising humic acid concentration to 1.5 gL^{-1} was ineffective in this situation, compared to 1.0 gL^{-1} (Table 3).

The general effect of nitrogen fertilizer levels on stem dry weight $plant^{-1}$ was significant and the trend was similar, in both summer seasons of 2010 and 2011. Soil application of nitrogen fertilizer at 200 kg fed^{-1} gave heavier stem dry weight $plant^{-1}$ than 150 kg fed^{-1}. However, raising nitrogen fertilizer level over 200 kg fed^{-1} did not show any significant increase on stem dry weight $plant^{-1}$ than 200 kg fed^{-1}.

Comparisons among the mean values of the interaction between humic acid concentrations and nitrogen levels indicated that, application of humic acid at 1.0 gL^{-1} together with nitrogen fertilizer at 250 kg fed^{-1} was superior and attained the heaviest weight of stem dry weight $plant^{-1}$, in both seasons.

Canopy dry weight plant^{-1}

Data presented in Table 3 showed that all humic acid concentrations reflected marked increases in canopy dry weight $plant^{-1}$ compared to control treatment. The differences between 0.0 and 0.5 gL^{-1} and between 0.5 and 1.0 gL^{-1} were significant, whereas, the increment between 1.0 and 1.5 gL^{-1} in canopy dry weight $plant^{-1}$ was not significant and the trend was the same in 2010 and 2011 seasons.

Application of nitrogen fertilizer showed that increasing the level from 150 to 200 kg fed^{-1} increased canopy dry weight $plant^{-1}$ significantly, whereas, raising nitrogen level from 200 to 250 kg fed^{-1} and from 250 to 300 kg fed^{-1} positively but not significantly increased canopy dry weight $plant^{-1}$ and the trend was similar in both seasons of the experiment.

The interaction between the two studied factors indicated that, application of humic acid at 1.0 gL^{-1} with nitrogen fertilizer at 250 kg fed^{-1} gave the heaviest weight of canopy dry weight $plant^{-1}$, in both seasons.

Yield and its Components

Number of fruits plant^{-1}

The results shown in Table 4 clarify that every increment of humic acid concentration increased the number of fruits $plant^{-1}$ significantly in the two seasons of 2010 and 2011.

Regarding the effects of nitrogen fertilization rates on number of fruits $plant^{-1}$, the results in Table 4. indicated that nitrogen increased the number in the two seasons. Generally, no marked increases noticed with increasing nitrogen rates except with the 300 kg fed^{-1} in the first season and 250 and 300 kg fed^{-1} in the second season comparing to the control.

The impact of interaction between the two studied factors (humic acid and nitrogen fertilizer) on number of fruits plant^{-1} was not significant, in 2010 and 2011 seasons.

Yield plant^{-1}

Yield plant^{-1} was a function of humic acid concentration, in the two experimental seasons. Application of humic acid at 0.5, 1.0 and 1.5 gL^{-1}, significantly, increased yield plant^{-1} by 20.5%, 33.9% and 45.2% in 2010 season, while amounted 22.2, 32.8 and 45.1% in 2011 season, respectively as compared to humic acid untreated-soil (Table 4).

Data presented in Table 4 illustrates the influence of nitrogen levels on yield plant^{-1} and declared that application of either 250 or 300 kg fed^{-1} gave pronounced increase over the control by 8.6% and 11.0% and by 8.9% and 11.8% in 2010 and 2011 seasons, respectively. No marked effect was noticed with 200 kg fed^{-1} in this respect.

The treatment combinations of humic acid concentrations and nitrogen fertilizer rates seemed to be not effective on yield plant^{-1}, in both seasons.

Fruit weight average

The general observed effect from the comparisons among the four studied concentrations of humic acid indicated that, soil application of humic acid, irrespective of the concentration used, appeared to be not effective on fruit weight average, in the two experimental seasons (Table 4).

The main effect of nitrogen fertilizer rates illustrate that, the differences among the four utilized nitrogen fertilizer rates in fruit weight average were non significant, in both seasons.

Comparisons among the mean values of the interaction between the two studied factors did not reflect any significant effect on fruit weight average, in 2010 and 2011 seasons.

Total yield fed^{-1}

The influence of humic acid with different concentrations on total yield was significant, in both 2010 and 2011 seasons. Soil application of humic acid at 0.5 , 1.0 and 1.5 gL^{-1} increased total yield fed^{-1} over the control by 21.1% , 32.3% and 45.1%, in 2010 season and 21.2%, 32.5% and 45.3 % in 2011 season (Table 4).

TABLE 4. Influence of different soil application rates of humic acid and nitrogen fertilizer on yield and its components of squash plant grown under reclaimed saline soil conditions during 2010 and 2011.

Humic acid, H (g L^{-1})	Season									
	2010					2011				
	Ammonium nitrite, N (kg fed^{-1})									
	150	**200**	**250**	**300**	**Mean**	**150**	**200**	**250**	**300**	**Mean**
	Number of fruits plant^{-1}									
0.0	4.8	4.8	5.0	5.4	**5.0**	5.0	5.0	5.3	5.6	**5.2**
0.5	5.7	5.7	6.3	6.0	**5.9**	5.9	6.0	6.5	6.2	**6.2**
1.0	6.0	6.1	6.6	7.3	**6.5**	6.2	6.4	6.9	7.5	**6.8**
1.5	7.0	7.0	7.7	7.6	**7.3**	7.3	7.3	8.0	7.9	**7.6**
Mean	**5.9**	**5.9**	**6.4**	**6.6**		**6.1**	**6.2**	**6.7**	**6.8**	
L.S.D at 5%	**N** 0.6		**H** 0.6		**N × H** n.s.	**N** 0.6		**H** 0.6		**N × H** n.s.
	Yield plant^{-1} (g)									
0.0	270	270	284	306	**283**	277	281	297	319	**293**
0.5	326	332	360	347	**341**	339	345	373	374	**358**
1.0	341	361	384	428	**379**	355	375	401	424	**389**
1.5	407	395	431	410	**411**	416	410	439	433	**425**
Mean	**336**	**339**	**365**	**373**		**347**	**353**	**378**	**388**	
L.S.D at 5%	**N** 27		**H** 27		**N × H** n.s.	**N** 25		**H** 25		**N × H** n.s.
	Fruit weight average (g)									
0.0	56.6	56.1	56.7	56.9	**56.6**	56.0	56.1	56.7	56.9	**56.4**
0.5	57.7	57.9	57.7	58.0	**57.9**	57.7	57.9	57.4	60.4	**58.4**
1.0	57.3	58.9	58.3	58.8	**58.3**	57.3	58.9	58.3	56.7	**57.8**
1.5	57.7	56.5	56.2	53.9	**56.1**	56.9	56.5	54.9	54.9	**55.8**
Mean	**57.4**	**57.4**	**57.3**	**56.9**		**57.0**	**57.4**	**56.9**	**57.2**	
L.S.D at 5%	**N** n.s.		**H** n.s.		**N × H** n.s.	**N** n.s.		**H** n.s.		**N × H** n.s.
	Total yield fed^{-1} (ton)									
0.0	3.77	3.82	4.03	4.33	**3.99**	3.93	3.97	4.20	4.51	**4.15**
0.5	4.65	4.62	5.06	5.01	**4.83**	4.84	4.80	5.28	5.20	**5.03**
1.0	4.84	5.12	5.50	5.68	**5.28**	5.03	5.33	5.73	5.90	**5.50**
1.5	5.71	5.64	6.01	5.82	**5.79**	5.94	5.88	6.27	6.03	**6.03**
Mean	**4.74**	**4.80**	**5.15**	**5.21**		**4.93**	**4.99**	**5.37**	**5.41**	
L.S.D at 5%	**N** 0.26		**H** 0.26		**N × H** n.s.	**N** 0.27		**H** 0.27		**N × H** n.s.

The influence of nitrogen fertilizer rates on total yield fed^{-1} was significant, in both 2010 and 2011 seasons. Soil application of nitrogen fertilizer at 250 and 300 kg fed^{-1} increased total yield fed^{-1} over 150 kg fed^{-1} rate by 8.7% and 9.9 %, in 2010 season and by 8.9% and 9.7 % in 2011 season, respectively. No marked effect was noticed with 200 kg fed^{-1}.

The treatment combinations of humic acid concentrations and nitrogen fertilizer rates seemed to be not effective on total weight, in both seasons.

Leaf Chemical Composition
Macro nutrients
Leaf nitrogen concentration

The influence of humic acid rates and nitrogen fertilizer levels on N, P and K concentrations of squash leaves are shown in Table 5.

Humic acid soil application significantly and progressively enhanced N concentration in leaves with the increment of humic acid rate in both seasons.

Nitrogen fertilization, markedly, enhanced N concentration in leaves of squash with increasing N fertilization up to 250 kg fed^{-1} while the rate 300 kg fed^{-1} was at bar with 250 kg fed^{-1} and the trend was the same in both seasons.

The interaction effect of the two studied factors on leaf N% was significant. The treatment combination of humic acid at 1.5 gL^{-1} together with nitrogen fertilizer at 200 kg fed^{-1} recorded the highest mean value in the two growing seasons.

Leaf phosphorus concentration

The main and interaction effects of humic acid concentrations and nitrogen fertilizer doses on leaf P% are shown in Table 5.

Comparisons among the four concentrations of humic acid indicated that, application of humic acid at concentrations 0.5, 1.0 and 1.5 gL^{-1} truly augmented leaf P% than the control treatment, in both seasons and the P % increased significantly and progressively with ever increment of humic acid rate.

The impact of nitrogen fertilizer rates applied to the growing squash plants on leaf P% was not significant, in the two experimental seasons.

No significant differences were detected on leaf P% as a result of the interaction between the various concentrations of humic acid and different levels of nitrogen fertilizer, in the two growing seasons.

Leaf potassium concentration

The main effect of humic acid applied at different rates on leaf K% was true, in both the experimental seasons. Application of humic acid, irrespective to the concentration used, significantly augmented leaf K% compared to the control. Moreover, the higher the concentration of humic acid the higher was the concentration of K in leaves (Table 5).

The general influence of nitrogen fertilizer applied at different rates on leaf K% was significant, during the two successive seasons. The comparisons among the four nitrogen fertilizer rates indicated that, soil application of nitrogen fertilizer led to significant depression in the concentration of K in leaves compared to the control, in both season. The relationship between nitrogen fertilizer rate and leaf K% was reversal.

Significant interaction effect between the two studied factors on leaf K% was obvious, in both years. At any level of nitrogen fertilizer, increasing humic acid concentration increased leaf K%. Reversely, at any concentration of humic acid, increasing nitrogen fertilizer rate decreased leaf K%. Therefore, the treatment combination of 0.0 humic acid and 300 kg nitrogen fertilizer fed^{-1} recorded the least value of leaf K%.

TABLE 5. Influence of different soil application rates of humic acid and nitrogen fertilizer on N, P and K% in leaves of squash plant grown under reclaimed saline soil conditions during 2010 and 2011.

Humic acid, H (g L^{-1})	Season									
	2010					2011				
	Ammonium nitrite, N (kg fed^{-1})									
	150	**200**	**250**	**300**	**Mean**	**150**	**200**	**250**	**300**	**Mean**
	N (%)									
0.0	2.03	2.31	2.50	2.65	**2.37**	2.11	2.40	2.61	2.76	**2.47**
0.5	2.24	2.52	2.70	2.82	**2.57**	2.33	2.62	2.82	2.93	**2.67**
1.0	2.48	2.78	2.92	2.98	**2.79**	2.58	2.90	3.04	3.10	**2.90**
1.5	2.76	3.10	2.96	2.78	**2.90**	2.87	3.22	3.09	2.89	**3.02**
Mean	**2.38**	**2.68**	**2.77**	**2.81**		**2.47**	**2.78**	**2.89**	**2.92**	
L.S.D at 5%	**N** 0.06		**H** 0.06		**N × H** 0.12	**N** 0.06		**H** 0.06		**N × H** 0.13
	P (%)									
0.0	0.26	0.26	0.27	0.26	**0.26**	0.27	0.27	0.28	0.27	**0.27**
0.5	0.31	0.30	0.31	0.31	**0.31**	0.33	0.32	0.33	0.33	**0.32**
1.0	0.36	0.36	0.37	0.37	**0.36**	0.37	0.37	0.38	0.39	**0.38**
1.5	0.42	0.41	0.41	0.42	**0.42**	0.43	0.43	0.43	0.43	**0.43**
Mean	**0.34**	**0.33**	**0.34**	**0.34**		**0.35**	**0.35**	**0.35**	**0.36**	
L.S.D at 5%	**N** n.s.		**H** 0.02		**N × H** n.s.	**N** n.s.		**H** 0.02		**N × H** n.s.
	K (%)									
0.0	3.02	2.96	2.64	2.53	**2.79**	3.14	3.08	2.76	2.64	**2.90**
0.5	3.18	3.10	2.92	2.69	**2.97**	3.30	3.23	3.04	2.80	**3.09**
1.0	3.34	3.22	3.16	3.03	**3.19**	3.48	3.35	3.29	3.15	**3.32**
1.5	3.56	3.42	3.30	3.16	**3.36**	3.70	3.56	3.44	3.29	**3.50**
Mean	**3.28**	**3.18**	**3.00**	**2.86**		**3.40**	**3.30**	**3.13**	**2.97**	
L.S.D at 5%	**N** 0.04		**H** 0.04		**N × H** 0.09	**N** 0.05		**H** 0.05		**N × H** 0.11

Micro nutrients

Leaf sodium concentration

Table 6 presents the main effects of soil application of humic acid and nitrogen fertilizer as well as their interaction on leaf Na%, throughout the two experimental seasons.

TABLE 6. Influence of different soil application rates of humic acid and nitrogen fertilizer on Na and Cl% in leaves of squash plant grown under reclaimed saline soil conditions during 2010 and 2011.

Humic acid, H ($g\ L^{-1}$)	Season									
	2010					2011				
	Ammonium nitrite, N ($kg\ fed^{-1}$)									
	150	200	250	300	Mean	150	200	250	300	Mean
	Na (%)									
0.0	1.01	1.00	0.94	0.82	**0.94**	1.05	1.04	0.98	0.86	**0.98**
0.5	0.86	0.72	0.65	0.61	**0.71**	0.89	0.75	0.67	0.64	**0.74**
1.0	0.63	0.60	0.52	0.49	**0.56**	0.66	0.62	0.55	0.51	**0.58**
1.5	0.45	0.45	0.40	0.38	**0.42**	0.46	0.47	0.42	0.39	**0.44**
Mean	**0.74**	**0.69**	**0.63**	**0.58**		**0.76**	**0.72**	**0.66**	**0.60**	
L.S.D at 5%	**N**	**H**	**N × H**			**N**	**H**	**N × H**		
	0.02	0.02	0.05			0.02	0.02	0.05		
	Cl (%)									
0.0	0.74	0.71	0.66	0.61	**0.68**	0.77	0.74	0.69	0.63	**0.71**
0.5	0.61	0.57	0.53	0.50	**0.55**	0.64	0.59	0.55	0.52	**0.57**
1.0	0.50	0.47	0.43	0.40	**0.45**	0.52	0.49	0.44	0.41	**0.47**
1.5	0.40	0.34	0.32	0.29	**0.34**	0.42	0.35	0.34	0.30	**0.35**
Mean	**0.56**	**0.52**	**0.49**	**0.45**		**0.58**	**0.54**	**0.51**	**0.47**	
L.S.D at 5%	**N**	**H**	**N × H**			**N**	**H**	**N × H**		
	0.02	0.02	n.s.			0.02	0.02	n.s.		

The detected differences among the obtained values of leaf Na% within the four utilized concentrations of humic acid were significant, in both seasons. Mean values of leaf Na% were in descending order as humic acid concentration increased up to the highest concentration.

The effect of nitrogen fertilizer levels on leaf Na% was significant and the trend was identical, through the two seasons. Increasing nitrogen fertilizer level from 150 to 200 and furtherly to 250 and 300 kg fed^{-1} achieved progressive significant reductions in leaf Na%.

Comparisons among the mean values of the interaction between the two studied factors showed that, at any level of nitrogen fertilizer, increasing humic acid concentration decreased leaf Na%. Likely, at any concentration of humic acid, increasing nitrogen fertilizer rate decreased leaf Na content.

Therefore, the treatment combination of 0.0 humic acid and 150 kg nitrogen fertilizer fed^{-1} recorded the highest magnitude of leaf Na% and on the other hand the combined treatment 1.5 gL^{-1} humic acid and 300 kg fed^{-1} recorded the lowest value of Na%

Leaf chloride concentration

Application of humic acid, irrespective of the concentration used, was responsible for the statistically inferior in leaf Cl% compared to the control, in the two growing seasons. Comparisons among the various concentrations of humic acid showed clearly that, application of humic acid at 1.5 gL^{-1} significantly recorded the least Cl content in leaves, in both seasons (Table 6).

The major influence of nitrogen fertilizer levels on leaf Cl% was significant and the trend was the same, in 2010 and 2011 seasons. Application of nitrogen fertilizer above 150 kg fed^{-1} up to 300 kg fed^{-1} was responsible for the statistically reduction in leaf Cl%. Comparisons among nitrogen levels, 200 , 250 and 300 kg fed^{-1} showed clearly that, application nitrogen fertilizer at 300 kg fed^{-1} significantly recorded the least concentration of Cl in leaves, in both seasons.

Comparisons among the mean values of the interaction between the two studied factors did not reveal any significant effect on leaf Cl%, in both seasons.

Discussion

Morphological characters

Vegetative growth parameters in terms of number of leaves, stem length, total leaf area $plant^{-1}$, leaf area $leaf^{-1}$ as well as leaves, stem and canopy dry weight $plant^{-1}$ (Tables, 2 and 3) were generally increased consistently with the soil application of humic acid at 0.5 to 1.5g L^{-1} as compared to zero humic acid. The positive influences of humic acid on vegetative growth could be mainly due to hormone-like activities of the humic acid through its involvement in cell respiration, photosynthesis, oxidative phosphorylation, protein synthesis, antioxidants and various enzymatic reactions (Zhang and Schmidt 1999, 2000). Among humic fractions, low molecular size ones (<350 dalton) induced morphological changes similar to those caused by indole-3-acetic acid (Muscolo *et al.*, 1993), and may also positively modify metabolism (Muscolo and Nardi, 1999). The presence of micro-nutrients, especially Fe, in humic acids or their colloidal nature make them have a positive effect on the growth of various groups of micro-organisms which may excrete a range of vitamins, hormone-like growth substances and antibiotics that may further promote the growth (Nardi *et al.*, 2002). In addition Zhang & Schmidt (2000), Nardi *et al.* (2002) and Zhang & Ervin (2004) reported that humic acids contain cytokinins and have auxin-like activity. In addition, Rady and Osman (2011) stated that humic acid may stimulate plant growth by acting as a plant growth regulator.

Furthermore, humic acid improves chemical properties of the soil because it increases soil micro-organisms, which enhance nutrient cycling (Sayed *et al*., 2007) and reduces soil pH in favor of root absorption of different nutrients (Osman and Ewees, 2008 and Osman & Rady, 2012). It seems that it promotes plant growth by its effects on ion transfer at the root level by activating the oxidation-reduction state of the plant growth medium and so increased absorption of nutrients by preventing precipitation in the nutrient solution. Furthermore, it enhances cell permeability, which in turn made for a more rapid entry of nutrients into root cells and so resulted in higher uptake of plant nutrients. These effects were associated with the function of hydroxyls and carboxyls in these compounds (Osman and Ewees, 2008).

Regarding to the effect of soil application with different levels of nitrogen on the vegetative growth parameters in terms of number of leaves, stem length, total leaf area plant^{-1}, leaf area leaf^{-1} as well as leaves, stem and canopy dry weight plant^{-1} (Tables, 2 and 3) were generally increased compared to 150kg fed^{-1}, the results can be explained by the general role of nitrogen on activation of photosynthesis and metabolism. These results were in agreement with those of Al-Harbi *et al.* (2008) who reported that fertilization with N may be used to reduce some of the negative effects of salinity on tomato plants. In addition, results of Cerda and Martinez (1988) on tomato indicated that nitrogen had a positive effect on germination and seedling growth under saline stress. In this concern, Mansour (2000) demonstrated that, phytohormones modulated by nitrogen nutrition, may also affect plant response to saline environment. For example, higher cytokinins content was found in nitrate treated plants compared with those receiving either ammonia or mixed nitrogen nutrition. Cytokinins can influence polyamines synthesis which may has protective function under salt stress (Mansour, 2000).

Nitrate and ammonium are the most abundant nitrogen sources for plants and their availability usually constitutes a limiting factor for plant growth and productivity (Causin and Barneix, 1993). The individual physiological responses of plants to nitrogen sources are quite different, probably due to their genetic makeup regarding varying ability to absorb and assimilate them (Botella *et al.,* 1994). Salinity stress markedly reduced plant growth and net assimilation rate and altered root to shoot biomass allocation (Tattini *et al.,* 2002). Trapani *et al.* (1999) stated that leaf area increased in response to nitrogen supply by increasing cell size and number.

The promotive effect of nitrogen on leaf area is obtained in the results of this study that is found to be in accordance with that reported by Bangarwa *et al.* (1988). The proper use of nitrogen in all soils is important particularly in saline soils, which alleviates the adverse effects of salinity on plant growth and yield (Soliman *et al.,* 1994, Albassam, 2001 and Flores *et al*., 2001). Abd-El-Fattah and Sorial (2000) on squash stated that increasing the fruits yield by the application of N levels may be due to the enhancement effect of nitrogen to vegetative growth and leaves area/plant which create a large surface available for photosynthesis. Nitrogen is an essential nutrient in creating the plant dry matter as well as many energy-rich compounds which regulates photosynthesis and plant production (Ng'etich *et al*., 2013).

Yield and its components

Results of the present study revealed that the addition of humic acid as soil amendments to the studied soil, which suffering from both salinity and sodicity condition, increased the squash yield.

The positive influences of humic acid on squash yield mainly due to its positive effect on number of fruits plant^{-1} and/or yield plant^{-1} as shown in Table 4. These increments may due to the vigorous growth of plants resulted in the hormone-like activities of the humic acid through their involvement in increasing, photosynthesis, oxidative phosphorylation, protein synthesis, antioxidant and various enzymatic reactions. (Muscolo *et al*., 1993 and Zhang & Schmidt, 2000). In addition, HA has been claimed to promote plant growth by increasing cell membrane permeability, oxygen uptake and photosynthesis, nutrient uptake, and root cell elongation (Russo & Berlyn, 1990, Böhme & Thi Lua, 1997 and Nardi *et al.*, 2002). The present findings were in harmony with those outlined by Abou Zied *et al.* (2005) who found that application of humic acid improves the productivity and its quality of some crops grown on a sandy soil. Therefore, it can be concluded that availability of nutrients evenly with humic acid mixed with saline soil was responsible for improving squash yield. Also, Maggio *et al.* (2003) who mentioned that such organic substances control stress adaptation responses including stomatal closure, osmotic adjustment and regulation of shoot versus root growth and modifications of root hydraulic conductivity properties.

The significant response of squash yields and its components to nitrogen application may be due to the improved biological conditions and increased root growth and utilization of nutrients released from the added or native nutrient sources on along the different growth stages enabling the grown plants to absorb more nutrients which reflected on yielding ability. These findings are in agreement with those reported by Kloepper (2003) who pointed out that the improvement in the biological conditions causes pronounced increases in plant root elongation by then uptake of more nutrients via the root system, and hence nutrients utilization. Furthermore, Abd-El-Fattah & Sorial (2000), Faten *et al.* (2010) and Ezzo *et al.* (2012) and Ng'etich *et al.* (2013) on squash plants stated that nitrogen application improves yields.

The higher plant dry weights obtained in this study with ammonium nitrate source of nitrogen supports the findings that crops supplied with both nitrate and ammonium produced higher yields because ammonium and sodium have antagonistic effect with each other (Camberato and Bock, 1989).

Chemical Composition

Data of this study showed that soil application with humic acid significantly improved the contents of N, P and K as well as reduced significantly the contents of Na and Cl in squash plants (Tables 5 and 6). This may be attributed to the increase in soil micro-organisms which enhance nutrient cycling (Sayed *et al*., 2007) and reduced soil pH (Osman & Ewees, 2008 and Osman & Rady, 2012), thus increased the availability of nutrients to be absorbed by plant roots. Humic acid also promotes plant growth through its effect on ion transfer at the root level by activating the oxidation-reduction state of the medium and increasing the absorption of nutrients by preventing their precipitation in the nutrient solution. In addition, humic would act as chelating agent, through -OH and -COOH as active groups for micronutrients and water molecules (Sayed *et al.,* 2007).

Nitrogen application increased N and decreased K concentration of leaves and it may due to the increase in root cation exchange capacity. Similar results were in agreement with those of Mitova and Atanasova (1998), He Yiqing (1999), Upendra *et al*. (2001) and Abd El-Rahman (2003) .

The increase in soil nutrients caused by the combined dose of nitrogen and humic acid (Table 5) was positively reflected in the nutrient composition of the squash plants. Moreover, the optimum leaf nutrient composition obtained with the combined treatment of nitrogen and humic acid could be explained by the improved availability of essential nutrients in the root zone, resulting from their solubilization caused by the released organic acids. This means that the soil application of humic acid plays an important role in increasing the supplying power of soil capacity against nutrient loss and deficiency.

On the other hand, Na and Cl contents (Table 6) were significantly reduced either by humic acid and/or nitrogen application probably due to the pronounced alleviation of soil salinity. This benefit was positively reflected on the vegetative growth and plant contents of N, P and K. Many studies have shown that high concentrations of Na^+ and Cl^- in the soil solution may depress nutrient–ion activities and produce extreme ratios of Na^+/Ca^{2+} and Na^+/K^+ in the plants, causing the plants to be susceptible to osmotic and specific ion injury as well as to nutritional disorders that resulted in reducing yield and quality (Grattan & Grieve, 1999, Essa, 2002 and Sivritepe *et al*., 2003). Studies indicate that an increase in concentration of K^+ in plants under salt stress could ameliorate the deleterious effects of salinity on growth and yield (Grattan & Grieve, 1999 and Sivritepe *et al.*, 2003). Similarly, Satti and Lopez (1994) in tomato and Kaya *et al*. (2003) on pepper and cucumber determined that an increase in the concentration of K^+ in the plants exposed to salt stress could ameliorate the deleterious effect of salt stress on the growth and yield. Plant growth promoting rhizobacteria have been shown to be able to provide the plant with important minerals, *e.g.* nitrogen, phosphate, potassium (Singh and Singh, 1993, Altomare *et al*., 1999, Grichko and Glick, 2001, Egamberdiyeva and Hoflich, 2003, Mayak *et al*., 2004) in the presence or absence of salinity.

Conclusion

Within the experimental conditions studied (reclaimed saline soil), it has been concluded that this work provided evidence about the role of humic acid as soil application to squash in increasing N efficiency, especially at the rate of 250 kg ammonium nitrate fed^{-1} with the soil application of water solution of humic acid using 1.5 gL^{-1}, as well as the humic acid reduced the soil pH and ECe (Osman and Rady, 2012) consequently allowing for more solubility and availability of nutrients for plant roots, which in turn positively reflected on growth, yield and chemical composition of squash plants cv. Amjjed, under favorable and unfavorable conditions, soil salinity and/or sodicity.

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زيادة كفاءة التسميد النيتروجينى بإضافة حمض الهيوميك لنباتات الكوسة النامية بالأراضى الملحية المستصلحة حديثًا

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أجرى هذا البحث بمزرعة دمو- كلية الزراعة- جامعة الفيوم خلال موسمين متتاليين (٢٠١٠ و ٢٠١١) لدراسة إمكانية زيادة كفاءة التسميد النيتروجينى (نترات أمونيوم ٣٣,٥٪) بمعدلات ١٥٠، ٢٠٠، ٢٥٠و ٣٠٠ كجم/ فدان تحت مستويات مختلفة للإضافة الأرضية لحمض الهيوميك (٩٠,٣٪) بمعدلات صفر، ٠,٥، ١,٠و ١,٥ جم/ لتر على النمو والمحصول والتركيب الكيميائى لنباتات الكوسة النامية تحت ظروف الأراضى الملحية المستصلحة حديثا بمحافظة الفيوم.

النتائج المتحصل عليها يمكن تلخيصها فى الآتى:

- أدت الإضافة الأرضية لحمض الهيوميك بأي معدلات إلى زيادة فى كل من طول الساق، الوزن الجاف للأوراق والسيقان والأجزاء الخضرية الهوائية، مساحه الأوراق الكلية ومساحه الورقة، عدد الثمار، محصول الثمار للنبات والمحصول الكلى للفدان كما أدت أيضا إلى زيادة محتوى الأوراق من النيتروجين، الفسفور والبوتاسيوم فى حين أدت إلى انخفاض تركيزات كل من الصوديوم والكلور بزيادة معدلات حمض الهيوميك المضافة للتربه خلال موسمى الدراسة.

- إضافة السماد النيتروجينى بمعدل ٢٥٠ كجم/ فدان أدت إلى زيادة معظم الصفات الخضرية والمحصول الكلى للنبات ومكوناته، كما أدت إلى خفض تركيز كل من البوتاسيوم والصوديوم والكلور فى الأوراق فى حين أدت إلى زيادة كل من تركيز النيتروجين والفسفور.

- وفى ضوء النتائج السابقة يمكن الاستنتاج أن كفاءة التسميد النيتروجينى قد ازدادت بالإضافة الأرضية لحمض الهيوميك مما أنعكس على زيادة النمو والمحتوى الكيميائى ومحصول الثمار للكوسة. وكانت أفضل معاملة إضافة الحمض الهيوميك بمعدل ١,٥ جم/ لتر مع التسميد النيتروجينى بمعدل ٢٥٠كجم نترات أمونيوم/ فدان حيث أعطت زيادة معنوية لمحصول الكوسة الكلى/ فدان (هجين أمجد) المنزرعة تحت ظروف الأراضى الملحية المستصلحة حديثًا.