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Role of humic acid and amino acids in limiting loss of nitrogen fertilizer and increasing productivity of some wheat cultivars grown under newly reclaimed sandy soil

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Abstract

Two field experiments were carried out at the experimental Station Farm of Kalabsho and Zayian district, Faculty of Agriculture, Mansoura University, North Nile Delta, Egypt**,** during the two successive winter seasons of 2013/2014 and 2014/2015,to study the effect of foliar application with humic acid, amino acid and mixture of humic and amino acids under nitrogen fertilizer levels (166, 214 and 262 kg N/ha) on yield,yield attributes and grain quality characters of three cultivars of bread wheat (Shaka 93, Gemiza 9 and Giza 168) grown in newly reclaimed sandy saline soil conditions. Gemiza 9 cultivar significantly surpassed other studied cultivars in the number of spikes/m^{2}and total carbohydrates in the first and second seasons. Highest values of spike length, number of grains/spike, grains weight/spike and thousand grains weight were obtained from Giza 168 cultivar in the first and second seasons, respectively. Giza 168 cultivar produced highest values of grain yield (4.809 and 5.729 t/ha) and straw yield (8.775 and 9.414 t/ha) over both seasons compared with other cultivars. Shaka 93 cultivar significantly surpassed other studied cultivars in grains protein (11.17 and 11.44%) in the first and second seasons, respectively. Foliar spraying with mixture of humic and amino acids resulted the highest values of yield attributes and increased grain and straw yields, protein and carbohydrates contents in grains by 23.29, 7.50, 10.98and 78.15%,respectively as compared with the control treatment over both seasons. Fertilizing with 262 kg N/ha resulted the highest values of yield attributes and significantly exceeded other studied levels (214 and 166 kg N/ha) by (23.45 and 43.74 %), (13.65 and 32.33%), (23.45and 43.74) and (13.65and 32.33) with concern grain and straw yields, protein and carbohydrates contents in grains over both seasons.

Keywords: Cultivars, humic acid, amino acids and nitrogen fertilizer.

Introduction

One of the most crucial functions of plant cells is their ability to respond to fluctuations in their environment. Understanding the connections between plants initial responses and the downstream events that constitute successful adjustment to its altered environment is one of the next grand challenges of plant biology **(El-Bassiouny *et al*. 2014)**.

Wheat (*Triticum aestivum* L.) is the most important and widely grown cereal crops in Egypt and all over the world. In that manner, wheat supplies about 20 percent of the food calories for the world's people. Although wheat is useful as a livestock feed. In Egypt, the total cultivated area of wheat reached about 1.425 million hectare and the total production exceeded

9.279 million tons with an average of 6.511 t/ha (**FAO, 2016**). The balance between the production and consumption of wheat represented about 40 of the national demands imported from foreign markets. For these reasons efforts should be directed toward increasing and improving the wheat yield, in order to fill the gap between production and consumption. To increase the cultivated area of wheat it is necessary to go to newly reclaimed soils. However, most of the newly reclaimed soils suffer from salinity problem. Where, salinity is one of the major abiotic stresses in arid and semi-arid regions that sustainability reduces the yield of major crops by more than 50%. Also, salinity limits soil fertility in irrigated regions of the world, this effect due to low rainfall in these areas besides soil leaching does not occur (**Corwin *et al*. 1996**). Although all soils contain some amount of soluble salts of multifarious nature, when soil and environmental conditions allow the concentrations in soil profiles to a high level, soil salinity becomes severe threat to land degradation and crop productivity **(Munnus, 2002)**. According to the Food and Agriculture Organization (FAO), about 20 to 30 million hectares of irrigated land are currently seriously damaged by salinity, and 0.25 to 0.50 million hectares are lost from production every year as a result of salt accumulation. It is well known that vertical expansion and maximize productivity of any crop could be achieved through using suitable agronomic practices. In addition, the pronounced role of the agronomical processes such as using promising cultivars, foliar fertilization with bio-stimulates substances such as humic acid and amino acids as well as nitrogen fertilizer levels has very imperative effect on the growth, yield and its attributes and chemical constituents of wheat crop.

Chosen the high yielding ability cultivars undoubtedly is very important to raise wheat productivity per unit area. For this reason, this study is aiming to evaluate the new promising cultivars for scooping light on the best cultivar that can be used under the environmental conditions of newly reclaimed sandy saline soils. **Abd El-Ghany *et al.* (2013)** reported that Sakha 93 cultivar produced higher grain weight/spike (2.07 and 1.95 g) and 1000-grain weight (42.82 and 42.50 g) as compared with Sakha 8 cultivar that produced the lowest of grain weight/spike (1.80 and 1.69 g) and 1000- grain weight (37.54 and 37.49 g) in the first and second seasons, respectively. This inheritance may be due to the tolerance variation to water deficiency and highly adaptability of Sakha 93 for sandy soil condition. **Mehasen *et al*. (2014)** found that Gemmaza 9 cultivar recorded number of spikes/m^2 (335.6 spike), spike length (14.00 cm), number of spikelets/spike (20.02 spikelets), grain yield (3376.8 kg/fed) and straw yield (3986.7 kg/fed). While, Giza 168 cultivar produced lowest values number of spikes/m^2 (300.0 spike), spike length (10.82 cm), number of spikelets/spike (19.00 spikelets), grain yield (2442.3 kg/fed) and straw yield (3385.2 kg/fed). Also Giza 168 gave the highest percentage of protein in grains (12.99%) as compared with other cultivars. **Seadh (2014)** found that Gemmiza 10 cultivar exceeded (Gemmiza 9 and Sakha 93) cultivars in number of spikes/m^2, number of spikelets/spike, number of grains/spike, grains weight/spike, grain and straw yields/fed. Gemmiza 9 cultivar registered the longest spikes and highest percentages of protein in grains. Sakha 93 cultivar recorded the highest weight of 1000-grains.

Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots. The main benefits of foliar spraying is that it can have up to a 90% efficiency rate of uptake as opposed to a 10% efficiency from soil applications. Also it becomes immediately available in the plant because they are 100% water soluble. This makes them perfect for correcting nutrient deficiencies. The other great thing is that foliar spraying stimulates the plants to create exudates in the roots which excite microbes to work harder and thus increases nutrient uptake from the soil. Foliar sprays are a great supplement to boost flavors, sweetness, mineral density and yield of crops (**Hsu, 1986**).Humic acid is a principal component of humic substances, which are the major organic constituents of soil (humus). Humic substances have many beneficial effects on soil physical structure and soil microbial populations as well as increase modify mechanisms involved in plant growth stimulation, cell permeability and nutrient uptake and increasing yield (**Cimrin and Yilmaz, 2005 and Asik *et al*. 2009**).

Recently, among the fertilization strategies, the foliar spraying with different molecules as humic acid have no harmful threat to the quality of the environment (**Senn, 1991**). **Khan *et al*. (2010**) found that humic acid (HA) applied alone at 3 kg/ha or in combination with half rate of nitrogen fertilizer (30 kg ha^{-1}) recorded the maximum yield of wheat. HA has great potential as a low cost natural fertilizer to improve soil fertility on sustainable basis. In the same trend, **Bakry *et al*. (2013**) concluded that foliar spraying wheat plants with humic acid at 13 mg/L significantly increased growth, yield components and grain yield.

Amino acids are a well known as bio-stimulant which has positive effects on plant growth, yield and significantly reduce the injuries caused by a biotic stresses. Foliar spraying with amino acids rapidly correct nutrients deficiencies due to its being readily absorbed and directly utilized to synthesis proteins. It helps to increase chlorophyll concentration leading to higher degree of photosynthesis, which makes crops lush. Amino Acids acts as a cytoplasm osmotic agent of stomatas cell, which help plants improve absorption of macro and trace nutrients as well as gasses through favoring the opening of stomatas. It as chelating agents helps the absorption and transportation of micronutrients inside the plant getting easier. It acts as equilibrium of soil microbial flora to improve mineralization of the organic matter and formation of a good soil structure and fertility around the roots (**Ashmead, 1986**). Foliara pplication each of humic and amino acids for wheat plant increased grain and straw yields, while the treatment including humic plus amino acids gave the highest yields than each alone (**El-Naggar and El-Ghamry, 2007**).

Nitrogen supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. The amount of applied nitrogen in plants must be carefully managed to ensure that, N will be available throughout the growing season and the vegetative and reproductive development will be not restricted (**Brich and Long, 1990 and Zhang *et al*. 2008**).Nitrogen uptake and utilization by plants and wheat are determined by genotypic differences and are linked to a variety of morphological and physiological factors, including the length and activity of the root system, the intensity of nitrate uptake, activity of nitrate reductase, sink of grains, carbohydrate production and N losses due to soil characteristics and leaching (**Fathi *et al*.1997and Shibu *et al*. 2010**). In spite of mineral nitrogen fertilizer have a good effect on plant productivity, nevertheless it's also have a pollutant effect on the environment. Whereas, it is more rapidly leaching to ground water, which affects human and animal health. **Seadh *et al.* (2008)** revealed that nitrogen fertilization at the level of 90 kg N/fed significantly exceeded other levels (50 and 70 kg N/fed) in photosynthetic pigments, growth characters, yield components and yield and quality characters over both seasons. **Antoun *et al.* (2010)** stated that raising mineral nitrogen fertilizer level from 25 to 50, 75 and 100 kg N/fed resulted in significant increases in spike length, grain and straw yields/fed and protein content of grains. Also, NPK uptake of grain and straw were significantly increased. **Atia and Ragab (2013**) revealed that grain and straw yields/fed and protein content were significantly increased by increasing nitrogen fertilizer levels from 0 to 30, 60 and 90 kg N/fed . **Attia *et al*. (2013)** stated that mineral fertilizing with 100 % of the recommended rate *i.e*. 75 kg N/fed gave the highest grain and straw yieldsand its components of wheat as compared with 67 or 133 % of the recommended rate .**Seleem and Abd El-Dayem (2013)** showed that the best significant values of grain and straw yields/fed were obtained by adding 60or 90 kg N/fed. On the other hand, the lowest ones were recorded for the control (without addition of nitrogen fertilizer). **Shirazi *et al*. (2014)** revealed that application of 80,110 and 120 kg N/ha were statistically identical in respect of spike length. The best nitrogen rate for the high economical increases of studied parameters was 80 kg N/ha, which gave the highest spike length (7.98 cm). While, maximum grain yield (2.15 t/ha) resulted from application of 100 kg N/ha. **Seadh and El-Metwally (2015)** showed that wheat plants fertilized with 100% of the recommended dose of nitrogen (80.0 kg N/fed) had the highest values of yield attributes, followed by plants fertilized with 80% of the recommended dose (64.0 kg N/fed) and lastly that fertilized with 60% of the recommended dose (48.0 kg N/fed) with significant differences among them in both seasons.

Therefore, this investigation was established to determine the effect of foliar application with humic acid, amino acid under nitrogen fertilizer levels on yield, yield components and grain quality characters of some cultivars of bread wheat grown in newly reclaimed sandy saline soil conditions in conditions in North Nile Delta, Egypt.

Materials and Methods

Study site and objective

The field experiments were conducted at the Experimental Station Farm in Kalabsho and Zayian region, Faculty of Agriculture, Mansoura University, North Nile Delta, Egypt, during the two successive winter seasons of 2013/2014 and 2014/2015.The objective of this study was decided the effect of foliar application with humic acid and amino acid in reducing nitrogen fertilizer requirements and maximizing yields and its attributes and grain quality of wheat cultivars grown in newly reclaimed sandy saline soil conditions. The Egyptian wheat cultivars *i.e.* (Shaka 93,Gemiza 9and Giza 168) were obtained from Wheat Research Section, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt and the pedigree of these cultivars are presented in Table 1.

Experimental design and treatments

Two experiments were designed in a strip-split plot design with three replicates. Each experiment included thirty six treatments comprising, three wheat cultivars, four foliar spraying treatments and three nitrogen fertilizer levels. The vertical-plots were included the following wheat cultivars:

1- Shaka 93
2-Gemiza 9
3- Giza 168

Table 1: The pedigree the studied wheat cultivars.

Name	Pedigree
Sakha 93	SAKHA92/TR810328 S.8871-1S-2S-1S-0S
Gemmiza 9	Ald “S” / Huac // Cmh 74A. 630 / Sx CGM 4583-5GM-1GM-0GM
Giza 168	MRL/BUE/SERI CM93046-8M-0Y-0M-2Y-0B

The horizontal-plots were devoted to four foliar spraying treatments as follows:

1- Spraying with water (control treatment).
2- Spraying with humic acid in the form of Actosol at the rate of 5 ml Actosol/liter water in each spraying.
3- Spraying with amino acids in the form of Amino-Cat at the rate of 5 ml Amino-Cat/liter water in each spraying.
4- Spraying with the mixture of Actosol and Amino-Catat the rates of 5 + 5/liter water, respectively in each spraying.

Humic acid is the active ingredient of Actosol product. Actosol is an organic biostimulant activator derived from a specialized coal referred to as leonardite. Leonardite is identical to natural humus which is the building block of natural organic matter in the soil. The natural organic fertilizer Actosol contains 1-5-6 NPK and 20 % humic acid, and manufactured by ArctickInc, Park Meadow Drive, Chantilly, VA, USA.

Amino-Cat as a source of amino acids contains of 11 % free amino acids + 3 % total N + 1 % P_2O_5 + 1 % K_2O.Amino acids improves the plant tolerance to stresses or adverse conditions *i.e.* high temperature, drought and salinity. Some amino acids play an important role in synthesis of some hormones such as auxins, increasing chlorophyll concentration, consequently increasing photosynthesis and act as chelating factor which help in transport and absorption of micronutrients.

The foliar solution volume was 475liter/ha and spraying was conducted by hand sprayer (for experimental plots) until saturation point three times after 30, 45 and 60 days from sowing.Tween-20 was used as a wetting agent at 0.02% concentration.

While, the sub – plots were allocated to nitrogen fertilizer levels (166, 214and 262 kg N/fed).

Nitrogen fertilizer in the form of ammonium nitrate (33.5 % N) was applied at the aforementioned levels as side – dressing in four equal doses prior every irrigation and finished before heading.

Each experimental unit area was 3 ×3.5 m occupying an area of 10.5 m^2. The soil in the summer season was uncultivated in both seasons.

The soil of experimental site was characterized as a little fertility and sandy saline soil as shown in Table 2, which cleared some mechanical and chemical properties according to **Piper (1950)** and **Black (1965)**. The irrigation water was found to be neutral in reaction (pH = 7.90 and 7.72) with a high level of soluble salts (EC= 6.10 and 6.30 dSm^{-1}) for two seasons of 2013/2014 and 2014/2015, respectively as shown in Table 2.

Table 2: Mechanical and chemical soil analyses of the experimental sites as well as some chemical properties of the irrigation water in 2013/2014 and 2014/2015 seasons.

Soil analyses	2013/2014 season	2014/2015 season
A: Mechanical analysis:		
Sand (%)	89.60	90.12
Silt (%)	8.10	7.60
Clay (%)	2.30	2.28
Soil texture class	Sandy	Sandy
B: Chemical analysis:		
CaCo3	0.43	0.41
Ph	8.49	8.43
E.C.($dS.m^{-1}$)	9.11	8.62
Organic matter (%)	0.65	0.42
Available N (ppm)	4.11	3.65
Available P (ppm)	5.35	3.75
ExchangeableK (ppm)	250.41	208.63
Irrigated water:		
E.C.($dS.m^{-1}$)	6.10	6.30
pH%	7.90	7.72
Solble ions (meq L^{-1}) – Cation – Ca^{++}	1.90	5.13
Solble ions (meq L^{-1}) – Cation – Mg^{++}	1.90	1.14
Solble ions (meq L^{-1}) – Cation – Na^{+}	1.31	1.02
Solble ions (meq L^{-1}) – Cation – K^{++}	1.61	1.78
Solble ions (meq L^{-1}) – Anion – $CO3^{-}$	-	-
Solble ions (meq L^{-1}) – Anion – $HCO3^{-}$	7.47	2.09
Solble ions (meq L^{-1}) – Anion – Cl^{-}	3.38	6.11
Solble ions (meq L^{-1}) – Anion – $SO4^{--}$	0.87	0.88

Soil Water Analysis Institute, Mansoura Lab., Agricultural Research Center.

Agricultural practices:

The experimental field was well prepared through two ploughings, compaction, division and then divided into the experimental units with dimensions as previously mentioned. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation (after ploughing and before division) at the rate of 476 kg/ha. Potassium sulphate (48 % K_2O) at the rate of 178 kg/ha was broadcasted in one dose before the second irrigation. Grains of wheat cultivars were sown at the rate of 190 kg/ha (according to 1000-grain weight of the studied cultivars), during the last week of November by using hand drilling Afar method in both seasons. The common agricultural practices for growing wheat according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

Studied characters

At harvesting, one square meter was randomly selected from each sub – plot to estimate the following characters: number of spikes/m^2, spike length (cm),number of spikelets/spike, number of grains/spike, grains weight/spike (g), thousand – grain weight (g), grain yield (t/ha). It was calculated by harvesting whole plants in each sub-plot and air dried, then threshed and the grains at 13 % moisture were weighted in kg and converted to ton per hectare (one hectare =10000 m^2).The straw resulted from previous sample was weighted in kg/plot, and then it was converted to ton per hectare. Crude protein percentage in grains. It was estimated by the improved Kjeldahl – method according to A.O.A.C. method (1990), modified by distilling the ammonia into saturated boric solution and titration in standard acid. Crude protein percentage was calculated by multiplying the total nitrogen values in wheat flour by 5.75. Carbohydrates percentage in grains. It was estimated using the anthrone method as described by **Sadasivam and Manickam (1996).**

Statistical analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip split – plot design as published by **Gomez and Gomez (1991)** by using MSTAT statistical package (MSTAT-C with MGRAPH version 2.10, Crop and Soil Sciences Department, Michigan State University, USA). Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by **Snedecor and Cochran (1980)**.

Results and Discussion

1. Cultivars Performance:

Cultivars caused significant effects on wheat yield attributes in both seasons as shown from results presented in Tables 3 and 4.Gemiza 9 cultivar significantly surpassed other studied cultivars in the number of spikes/m^2(338.1 and 346.6)in the first and second seasons only. Highest values of spike length (9.92 and 10.13 cm),number of grains/spike (58.80 and 61.69 grains),grains weight/spike (2.583 and 2.883 g) and thousand grains weight (42.94 and 46.49 g)were obtained from Giza 168 cultivar in the first and second seasons, respectively. There were significant differences among cultivars on grain and straw yields as well as grain quality (protein and carbohydrates contents) in both seasons (Table 4). Gemiza 9 cultivar significantly surpassed other studied cultivars in total carbohydrates (77.09 and 79.70 %)in the first and second seasons. Giza 168 cultivar produced highest values and significantly increased grain yield (4.809 and 5.729 t/ha) and straw yield (8.775 and 9.414 t/ha) over both seasons compared with other cultivars. Shaka 93 cultivar significantly surpassed other studied cultivars in grains protein and produced the highest values (11.17 and 11.44%) in the first and second seasons, respectively. The variation among wheat cultivar in these parameters may be due to the genetical variation of them as demonstrated in Table 1. Similar results were obtained by **Abd El-Ghany *et al*. (2013), Mehasen *et al*. (2014) and Seadh (2014).**

2. Effect of foliar spraying treatments:

Relevant results presented in Tables 3 and 4 show that the effect of foliar spraying treatments on yield attributes as significant in both seasons. There were substantial differences in all studied yield and its components among foliar spraying treatments (spraying with humic acid, amino acids and the mixture of humic and amino acids) as compared with control treatment (without foliar spraying) in both seasons. Foliar spraying with the mixture of humic acid and amino acidsproduced highest values of number of spikes/m^2,spike length, number of spikelets/spike, number of grains/spike, grains weight/spike and thousand grains weight. The corresponding data were (347.5 and 368.8 spikes), (9.62and 10.17 cm),(18.94 and 19.76spikelets), (56.70 and 59.77grains),(2.564 and 2.817 g) and (44.83 and 46.77 g) in the first and second seasons, respectively. On the other hand, control treatment (without foliar spraying) produced the lowest values of these characters in the two growing seasons. The effect of foliar spraying treatments on wheat yields and grain quality was significant in both seasons (Table 4). From obtained results, It could be noticed that foliar spraying wheat plants with the mixture of humic acid and amino acids increased grain and straw yields, protein and carbohydrates contents in grains by 23.29,21.39, 23.12and 3.67%, respectively as compared with the control treatment over both seasons. Humic acid stimulate the biochemical processes in plants such as photosynthesis and total chlorophyll content which consequently increased yield and quality (**Akinremi *et al*. 2000**). **Khan *et al*. (2010) and Bakry *et al*. (2013**) confirmed our results, whom concluded that humic acid had promoting effects on plant growth, grain yield

Table 3: Number of spikes/m^2 and spike length, number of spikelets/spike, number of grains/spike and grains weight/spike as affected by foliar spraying and nitrogen fertilizer levels of some wheat cultivars as well as their interactions during 2013/2014 and 2014/2015 seasons.

Characters / Treatments	Number of spikes/m^2		Spike length (cm)		Number of spikelets/spike		Number of grains/spike		Grains weight/spike (g)	
	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015
A- Cultivars:										
Shaka 93	277.8	288.5	8.91	9.67	17.30	18.52	45.80	48.52	1.936	2.218
Gemiza 9	338.1	346.6	8.67	9.41	18.08	19.08	50.63	51.63	2.049	2.198
Giza 168	313.2	333.0	9.92	10.13	18.08	18.61	58.80	61.69	2.583	2.883
F. test	*	*	*	*	NS	NS	*	*	*	*
LSD at 5 %	20.6	18.0	0.57	0.45	-	-	2.43	2.46	0.185	0.188
B-Foliar spraying:										
Control treatment	264.5	272.5	8.63	9.17	16.47	17.50	44.37	46.14	1.733	1.955
Humic acid (HA)	303.7	316.8	9.17	9.78	17.63	18.72	55.00	57.44	2.339	2.600
Amino acids (AA)	323.1	332.5	9.25	9.83	18.23	18.96	50.92	52.44	2.122	2.360
Mixture of HA + AA	347.5	368.8	9.62	10.17	18.94	19.76	56.70	59.77	2.564	2.817
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	33.4	33.1	0.24	0.32	0.61	0.56	2.57	2.57	0.157	0.180
C- Nitrogen fertilizer levels:										
166 kg N/ha	268.4	276.8	8.91	9.41	16.81	17.73	46.16	47.66	1.826	2.011
214 kg N/ha	307.7	317.0	9.13	9.73	17.90	18.82	52.16	54.19	2.189	2.421
262 kg N/ha	353.0	374.3	9.46	10.08	18.75	19.66	56.91	60.00	2.553	2.866
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	20.5	18.4	0.15	0.11	0.53	0.52	1.64	1.55	0.108	0.099
D- Interactions:										
A × B	*	NS	NS	NS	NS	NS	NS	NS	NS	*
A × C	*	NS	NS	NS	NS	NS	NS	NS	NS	NS
B × C	NS	NS	NS	NS	*	*	*	*	*	*
A × B × C	NS	NS	NS	NS	NS	*	NS	*	NS	NS

Table 4: Thousand grains weight, grains weight, straw yield, protein and carbohydrate percentages as affected by foliar spraying and nitrogen fertilizer levels of some wheat cultivars as well as their interactions during 2013/2014 and 2014/2015 seasons.

Treatments \ Characters	**Thousand grains weight (g)**		**Grain yield (t/ha)**		**Straw yield (t/ha)**		**Protein (%)**		**Carbohydrates (%)**	
	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015	2013 /2014	2014 /2015
A- Cultivars:										
Shaka 93	42.60	45.30	3.274	3.593	5.451	6.005	11.17	11.44	76.37	78.29
Gemiza 9	40.02	42.27	4.101	4.811	8.155	8.854	10.18	10.56	77.09	79.70
Giza 168	42.94	46.49	4.809	5.729	8.775	9.414	10.87	10.90	76.73	78.47
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.46	1.36	0.208	0.195	0.914	0.800	0.44	0.31	0.70	0.80
B-Foliar spraying:										
Control treatment	38.64	41.98	3.597	4.352	6.744	7.255	9.70	9.76	75.17	77.53
Humic acid (HA)	42.56	45.05	4.166	4.781	7.577	8.139	10.35	10.56	77.25	79.30
Amino acids (AA)	41.38	44.95	3.876	4.554	7.354	8.142	11.12	11.37	76.27	78.36
Mixture of HA + AA	44.83	46.77	4.607	5.157	8.166	8.829	11.78	12.18	78.22	80.08
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.48	1.48	0.181	0.171	0.697	0.713	1.34	1.33	0.69	0.45
C- Nitrogen fertilizer levels:										
166 kg N/ha	39.41	42.13	3.364	3.946	6.401	6.977	10.34	10.77	76.58	78.49
214 kg N/ha	41.52	44.35	3.966	4.538	7.483	8.091	10.61	11.05	76.87	78.89
262 kg N/ha	44.63	47.57	4.855	5.649	8.496	9.205	11.26	11.08	76.73	79.07
F. test	*	*	*	*	*	*	*	*	NS	*
LSD at 5 %	1.30	1.24	0.126	0.101	0.401	0.390	0.18	0.11	-	0.37
D- Interactions:										
A × B	*	NS	*	*	*	*	NS	NS	NS	*
A × C	NS	NS	*	*	*	*	NS	NS	NS	*
B × C	NS	NS	*	*	*	*	NS	NS	NS	NS
A × B × C	NS	NS	*	*	*	*	NS	NS	NS	NS

and quality of wheat. In addition, the beneficial role of humic acid on growth and yield, humic acid have no harmful threat to the quality of the environment (**Senn, 1991**).On other hand, amino acids have a good mobility and tendency to be transported in plants.Many vital plant mechanisms are stimulated after application of amino acids, this fact characterizes amino acids as a real biostimulants able to equilibrate the nutritional functions. The positive effect of amino acids on plant growth and yield may be due to improving the original ultrastructure in the cell especially the plastids in mesophyll tissue which improving photosynthetic efficiency leading to production of more assimilates needed for formation of new cell reflected to increase plant height, leaf area, tillers as well as yield and its components. Moreover, amino acids stimulate the activity of some enzymes responsible protein and carbohydrates synthesis and therefore the biomass and this action is directly correlated with the yields. These results are partially in line with those reported by **Mladenova *et al*. (1998**). Similar results were found by (**El-Naggar and El-Ghamry (2007)**.

3. Effect of nitrogen fertilizer levels

The results presented in Table 3 and 4 revealed that the effect of nitrogen fertilizer levels on yield attributes were significant in the two growing seasons. It can be stated that all studied yield attributes were significantly steady increased as a result of increasing nitrogen fertilizer levels from 166,214 and 262 kg N/ha and the differences between them were obvious in both seasons. Application the highest level of nitrogen fertilizer (262 kg N/fed) produced the highest values of number of spikes/m^2 (353.0 and 374.3), spike length (9.46 and 10.08 cm), number of spikelets/spike (18.75 and 19.66), number of grains/spike (56.91and 60.00), grainsweight/spike (2.553 and 2.866 g) and Thousand grains weight (44.63 and 47.57g) in the first and second seasons, respectively. Data presented in Tables 3 indicate that the effect of nitrogen fertilizer levels on grain and straw yields as well as grain quality was significant in the two seasons. It can be stated that all studied characters of wheat plants gradually increased as a result of increasing nitrogen fertilizer levels from 166 up to 262 kg N/ha. Mineral fertilizing with 262 kg N/ha significantly exceeded other studied levels (214 and 166 kg N/ha) by (23.45 and 43.74 %), (13.65and 32.33%), (23.45and43.74) and (13.65and32.33) with concern grain and straw yields, protein and carbohydrates contents in grains over both seasons. The increase in growth and yield attributes characters associated with increasing nitrogen fertilizer levels may be attributed to the role of nitrogen in improving wheat growth by enhancement meristematic activity and cell division which caused increases in internodes length and number of fertile tillers per unit area and also metabolic, photosynthesis processes and forming filled grains consequently producing heavier grains (**Seadh *et al*. 2009**). The desirable effect of higher nitrogen fertilizer level on yields and grain quality can be easily ascribed to the nitrogen which consider as one of the major elements for plant nutrition and it increases the vegetative cover for plant and forms strong plants with long spikes. Moreover, nitrogen encourages plant to uptake other elements activating, thereby growth of plants, consequently enhancing growth measurements and all yield components. These results are in agreement with those reported by **Seadh *et al*. (2008**), **Antoun *et al*. (2010**) **and Shirazi *et al*.(2014).**

4. Effect of interactions

Three way interaction among cultivars, foliar spraying and nitrogen fertilizer levels showed significant effect on number of spikelets/spike, number of grains/spikein the second season only, grain and straw yields (t/ha)in both seasons as presented in Tables 3 and 4. On the other hand, all interactions presented in the above mentioned Tables. Data presented in Fig. 1 show that foliar spraying Gemiza 9 cultivar with the mixture of humic acid and amino acids and mineral fertilized with 262 kg N/ha produced the highest number of spikelets/spike in the second season. The second best interaction treatment was foliar spraying Gemiza 9 cultivar with the mixture of humic acid and amino acids and mineral fertilized with 214 kg N/ha.

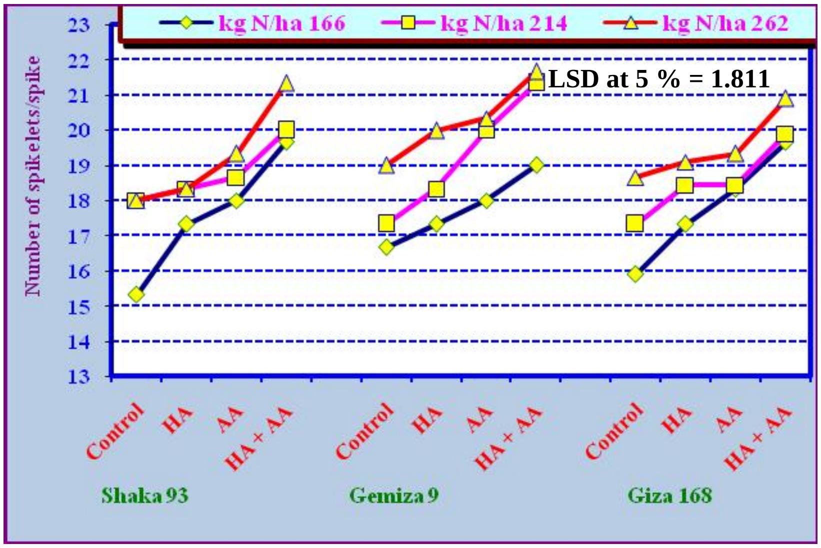

Fig. 1: Number of spikelets/spike as affected by the interaction among wheat cultivars, foliar spraying and nitrogen fertilizer levels during 2014/2015 season.

The highest number of grains/spike resulted from foliar spraying Giza 168 cultivar with the mixture of humic acid and amino acids in addition mineral fertilizing with 262 kg N/ha (Fig.2). The second best interaction treatment was foliar spraying Giza 168 cultivar with the mixture of humic and amino acids in addition mineral fertilizing with 214 kg N/ha.

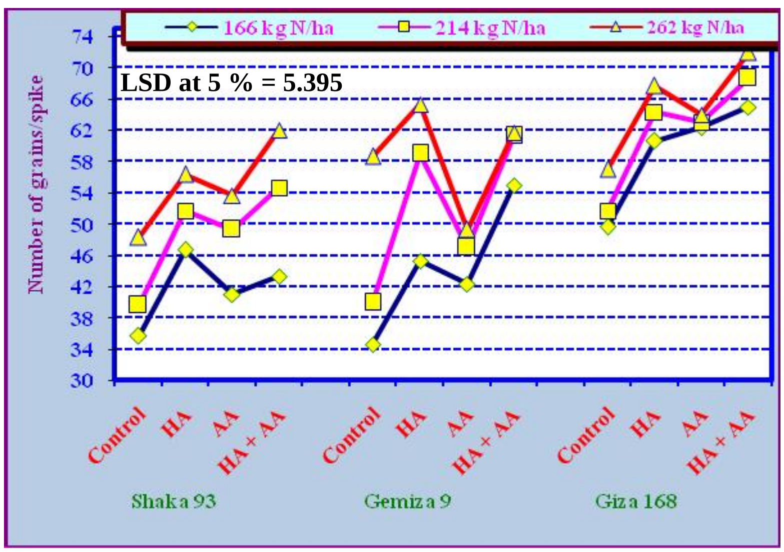

Fig. 2: Number of grains/spike as affected by the interaction among wheat cultivars, foliar spraying treatments and nitrogen fertilizer levels during 2014/2015 season.

The interaction among three studied factors excreted significant effect on grain yield/ha in both seasons. as graphically demonstrated in Fig. 3 were obtained from foliar spraying plants of Giza 168 cultivar with the mixture of humic and amino acids in addition mineral fertilizing with 262 kg N/ha. This interaction treatment followed by foliar spraying Giza 168 cultivar with humic acid and mineral fertilizing with 262 kg N/ha and then foliar spraying Giza 168 cultivar with amino acids and mineral fertilizing with 262 kg N/ha in both seasons.

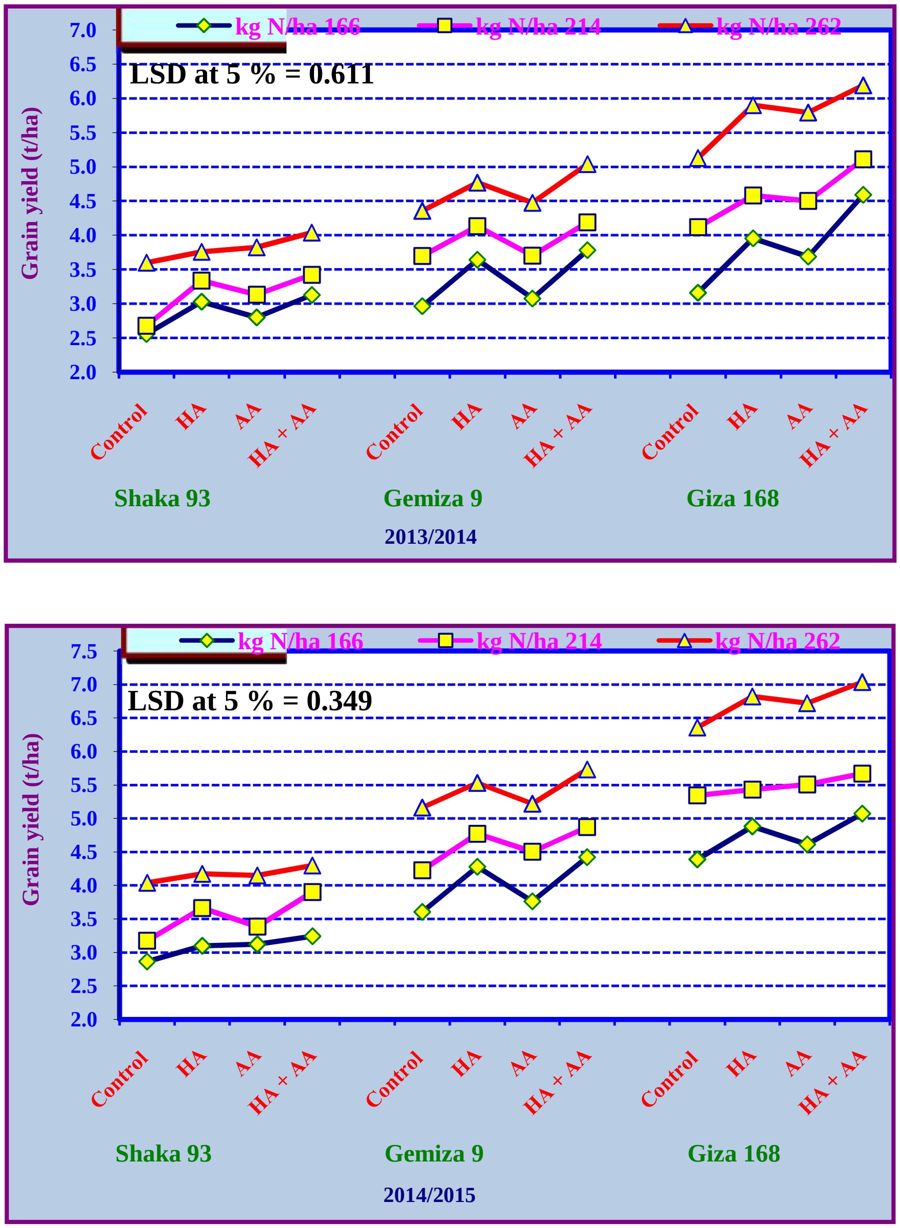

Fig. 3: Grain yield (t/ha) as affected by the interaction among wheat cultivars, foliar spraying treatments and nitrogen fertilizer levels during 2013/2014 and 2014/2015 seasons.

The interaction among cultivars, foliar spraying treatments and nitrogen fertilizer levels exhibited significant effect on straw yield/ha in both seasons. The highest values of straw yield/ha resulted from foliar spraying plants of Giza 168 cultivar with the mixture of humic and amino acids in addition mineral fertilizing with 262 kg N/ha (Fig. 4). This interaction treatment followed by foliar spraying Gemiza 9 cultivar with the mixture of humic and amino acids in addition mineral fertilizing with 262 kg N/ha and then foliar spraying Giza 168 cultivar with humic acid and mineral fertilizing with 262 kg N/ha in both seasons.

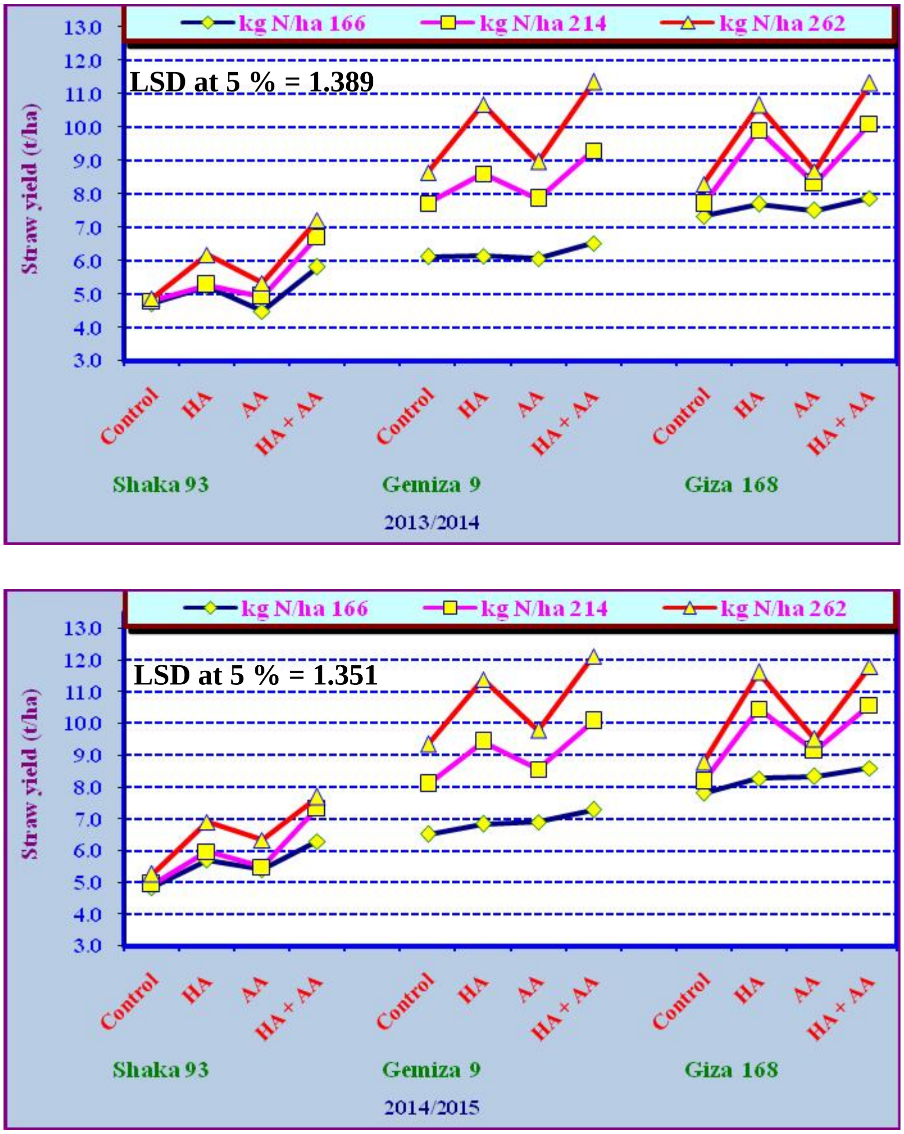

Fig. 4: Straw yield (t/ha) as affected by the interaction among wheat cultivars, foliar spraying treatments and nitrogen fertilizer levels during 2013/2014 and 2014/2015 seasons.

Conclusion

Form obtained data in this study, it can be foliar spraying wheat plants Giza 168 cultivar with the mixture of humic and amino acids with addition mineral fertilizing with 262 kg N/ha and produced the best of grain yield under newly reclaimed sandy saline soil conditions in North Nile Delta, Egypt.

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