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Response of Two Wheat Cultivars to Foliar Application with Amino Acids under Low Levels of Nitrogen Fertilization

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ABSTRACT

This study was conducted in the two successive winter seasons of 2014/2015 and 2015/2016 at the Agricultural Experimental Farm of Al-Azhar Univ. at Assiut, to study the response of two cultivars of wheat (Sids-1 and Sids-12) to foliar application of amino acids (control, 2.5 and 5 ml/L) and different nitrogen fertilizer rates (30, 45 and 60 kg N /fed.). The experiments were performed in a split-split plot design with three replicates; where wheat cultivars were assigned to the main plot, while nitrogen rates and amino acids were distributed randomly in the sub and sub-sub plot, respectively. The obtained results showed that wheat cultivars exhibited significant differences in flag leaf area in both seasons, except plant height, number of tillers/plant and number of grains/spike in the first season only, as well as number of leaves/plant and 1000-grains weight in the second season only. On other hand, number of spikes/m^2, grain yield/fed., straw yield/fed., protein and carbohydrate percentage didn't show significant differences in both seasons. Sids-12 cultivar was superior to Sids-1 in all studied traits except of grain yield/fed., in the first season only Sids-1 was superior to Sids-12. Increasing the level of nitrogen fertilizer from 30 or 45 to 60 kg N /fed. caused a significant increases in all traits under study in both seasons. Foliar application with amino acids significant increases in all studied characters, i.e. plant height, number of leaves/plant, number of tillers/plant, flag leaf area, number of spikes/m^2, number of grains/spike and 1000-grains weight (g) as well as grain and straw yields/fed. Also, such treatment increased protein and carbohydrate percentages of wheat grains. The interaction between nitrogen rates and foliar application of amino acids had a significant effect on plant height, number of leaves/plant, flag leaf area, number of spikes/m^2 and number of grains/spike in both seasons and 1000-grains weight and protein percentage in the second season only. Concerning the interaction between cultivars and nitrogen fertilizer rates were significant on flag leaf area in the first season only. The interaction between cultivars and foliar application of amino acids were significant on plant height in both seasons. In general, the highest value of grain yield/ fed. was obtained from Sids-1 and Sids-12 cultivars when received 60 kg N/fed. and foliar application of amino acids under Assiut conditions. It is recommended to use foliar application of amino acids with a reduced level of chemical nitrogen fertilizer to improve growth and yield of wheat and to decrease the environmental pollution resulting from using high amount of large chemical fertilizers.

Key words: wheat, cultivars, foliar application, amino acids, nitrogen fertilizer.

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops grown in the world which plays a key role in the economic activity. It is used as a stable food grain for urban and rural societies and as a major source of straw for animal feeding. In Egypt, the cultivated area was around 3 million faddan yearly. Increasing the cultivated area of wheat should be done in the reclaimed land due to the limited areas of the Nile Valley and the competition of the main crops. Therefore, improving both quantitative and qualitative characteristics of wheat was still the aim of many investigators.

Grain yield of wheat is affected by many factors, of which cultivar, nitrogen fertilizer and amino acids play an important role in determining productivity of wheat. Nitrogen is generally the most common limiting nutrient for growth and yield of crops worldwide. In cereals, nitrogen limits grain yield and quality via effects on plant biomass and consequently on grain number, size and protein concentration. Abou-Salama *et al.* (2000) reported that increasing nitrogen fertilizer rates (50, 75 and 100 kg N/fed.) to wheat increased the plant height, number of spikes/m^2, grain yield/fed., straw yield/fed. and seed index. Saad (2007) concluded that increasing nitrogen fertilization rate (60, 80 and 100 Kg N/fed.) to wheat had significant increases in plant height, number of tillers/ plant, flag leaf area, number of spikes/m^2, number of grains/spike, 1000-grains weight, grain yield/fed., straw yield/fed. and protein percentage. Bayoumi and

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El-Demardash (2008) reported that increasing nitrogen fertilizer level (40 and 120 kg N/fed.) to wheat increased the 1000-grains weight, protein and carbohydrate percentage. Shekoofa and Emam (2008) found that all studied parameters (plant height, number of leaves/plant and 1000-grains weight,) were significantly increased due to increasing the level of nitrogen fertilization from (0, 100 or 200) Kg N/ha. Gehan *et al.* (2011) showed that nitrogen fertilizer at rates 35, 70 and 105 kg N/fed. significantly increased plant height, number of spikes/m^2 , number of grains/spike, 1000-grains weight, straw yield, protein and carbohydrate percentage. Santosh (2011) indicated that nitrogen levels supply on plant height and flag leaf area were significantly enhanced at all applied treatments.

The importance of amino acids came from their widely use for the biosynthesis of a large variety of nonproteinic nitrogenous materials, i.e. pigments, vitamins, coenzymes, purine and pyrimidine bases. Studies have proved that amino acids can directly or indirectly influence the physiological activities in plant growth and yield (Mohamed 2006). Azimi *et al.* (2013) pointed out that foliar application of amino acids gave the highly significant increase in plant height, number of tillers/m^2, number of grains/spike, 1000-grains weight and grain yield to wheat; Salwa and Osama (2014) the obtained results revealed that foliar spraying of amino acids induced significant increases in plant height, No. of leaves/plant, No. of tillers/plant, flag leaf area, No. of spikes/m^2, No. of grains/spike, 1000-grain weight, grain yield (ton/fed), straw yield (ton/fed), protein and carbohydrate percentage in grain. Raupeliene, (2015) showed that liquid amide nitrogen fertilizers with 1.0, 2.5 and 3.0 % amino acids concentrations applied at booting stage influenced a significant winter wheat grain yield increase of 0.27–0.4 t ha., as compared with non-treated plants. The highest yield (6.46 t ha.) was produced in the treatment with 2.5 % amino acids solution applied at booting stage.

The differences between wheat cultivars were recorded in plant height, number of spikes/m^2 , number of grains/spike, 1000-grains weight and grain yield/fed. (Allam 2003, El-Nagar 2003 and Bakry *et al.* 2013), number of leaves/ plant (Mirzamasoumzadeh *et al.,* 2012), number of tillers/plant (Mahdy and Teama 2000 and Bakry *et al.* 2013), flag leaf area (Santosh 2011, Ahmad 2013 and Guendouz *et al.* 2016), straw yield/fad and protein percentage in grain (El-Desoky and El-Far 1999, Allam 2003 and Bakry *et al.* 2013), carbohydrate percentage in grain (Mervat *et al.* 2013 and Sonia and Mohammad 2013).

Materials and Methods

Two field experiments were conducted at the Agricultural Experimental Farm of Al-Azhar Univ. at Assiut, during 2014/2015 and 2015/2016 seasons to study the response of two cultivars of wheat (Sids-1 and Sids-12) to foliar application of amino acids (control, 2.5 and 5 ml/L) and different nitrogen fertilizer rates (30, 45 and 60 kg N /fed.). The preceding summer crop was maize in both seasons. The experiments were performed in a split-split plot design with three replicates where, wheat cultivars were assigned to the main plot, while nitrogen rates and amino acids were distributed randomly in the sub and sub-sub plot, respectively. The experimental unit comprised each 3.5m long and 3.0 m wide (10.5 m^2 in area = 1/400/ fed.). Grain were sown on Nov. 20th 2014 and Nov. 25th 2015, respectively. Nitrogen rates under test were 30, 45 and 60 kg N /fed. as ammonium nitrate (33.5%N) applied in two equal doses at first irrigation and second irrigation. Foliar application of amino acids levels (control, 2.5 and 5 ml/L) were sprayed two times, the first one after 25 days from sowing and the second a month after the first foliar application. For the natural bio stimulants, the plants were treated with amino acids. The commercial product "Amino plus" was used as simulative compound source for amino acids mixture. "Amino plus" is a brown liquid with pH of 5.5 and containing amino acids mixture as follows (g/100 ml solution): Aspartic (1.56), Threonine (1.02), Serine (2.21), Glutamic (2.62), Proline (2.55), Glycine (1.78), Alanine (1.41), Valine (1.74), Leucine (1.77), Isoleucine (1.07), Tyrosine (0.40), Phenylalanine(0.94), Histidine (0.14), Lysine (0.33), Arginine (1.66), Cystine (0.87) and Methionine (0.08). All other practices were uniformly applied as recommended for wheat production in the region. The physical and chemical analyses of the experimental site are presented in Table (1)

Table 1: The mechanical and chemical analysis of soil field experiments

Mechanical analysis	2014/2015	2015/2016	Chemical analysis	2014/2015	2015/2016
Sand (%)	24.80	25.50	Organic matter (%)	0.98	1.01
Silt (%)	38.90	39.50	Available N (ppm)	74.40	76.50
Clay (%)	36.30	35.00	Available P(ppm)	9.60	10.56
Soil texture	Clay loam		Available K (ppm)	355.15	363.25
			pH (s.p. 65)	7.73	7.99
			E.C. (ds. m^{-1})	1.16	1.17
			Total $CaCo_3$ (%)	2.86	2.61

The studied characters:-

A- Growth characters:-

After 90 days from sowing, ten plants were randomly selected from each treatment and the following data were recorded:-

1- Plant height (cm).
2- Number of leaves/plant.
3- Number of tillers/plant.
4- Flag leaf area (cm^2): the flag leaf area was calculated using the following equation of Palamiswamy and Gomex (1974). Leaf area (L.A) = K(L x W). Where: L= leaf length, W = maximum width of the leaf. K=factor of 0.75

B- Yield and yield components:

1- Number of spikes/m^2: counted in randomly chosen one meter square in each plot.
2- Number of grains/spike.
3- 1000-grains weight (g): average weight of 1000-grains randomly taken from each plot.
4- Grain yield (ton/fed.): weight of grains harvested from each plot converted to ton (ton 1000 kg)
5- Straw yield (ton/fed.): it was calculated by subtracting grain yield from the total yield for each plot and converted to ton/fed.

C-Grain quality:-

1- Protein (%): Protein percentage in the dry grains were calculated by multiplying N% by the factor of 5.70 which determined by using the micro Kjeldahl method as described by A.A.C.C (2000).
2- Carbohydrate (%): Total carbohydrate percentage in the dry grains were estimated using the method described by Dubois *et al.* (1956).

Statistical analysis:-

The results were statistically analyzed according to Gomez and Gomez (1984) using the computer MSTAT-C statistical analysis package by Freed *et al.* (1989). The least significant differences (LSD) test at probability level of 0.05 was manually calculated to compare the differences among means.

Results and Discussion

A- Growth characters:-

1- Performance of cultivars:

The results in Tables (2, 3, 4 and 5) revealed that flag leaf area was significantly affected by cultivars in both seasons as well as plant height and number of tillers/plant in the first season only, also number of leaves/plant were significantly affected by cultivars in second season only. Sids-12 cultivar surpassed on Sids-1 cultivar in plant height, number of leaves/plant, number of tillers/plant and flag leaf area. This mean that the difference between cultivars is mainly due to the difference in their genetic make up and their reaction to the environments condition prevailing during it growth. These results agree with those obtained by Allam (2003), Bahram *et al.*(2012), Ahmad (2013) and Bakry *et al.* (2013).

2 – Effect of nitrogen fertilizer:

Data in Tables (2, 3, 4 and 5) reveled that the all studied traits had a significantly affected by nitrogen fertilizer in both seasons. Increasing nitrogen fertilization up to 60 kg N/fed. gave the highest values of the plant height, number of leaves/plant, number of tillers/plant and flag leaf area as compared with the other treatments (30 0r 45 N/ fed.). in the two growing seasons. . The increase in these characters with the increase of nitrogen level might due to the role of nitrogen in activating the growth. This reflects the important of nitrogen in building up the photosynthetic area of wheat plants and consequently accumulation of more dry matter, which is reflected in these characters. Similar results were obtained by Saad (2007) and Shekoofa and Emam (2008).

Table 2: Effect of nitrogen fertilization and amino acids spraying on plant height of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Plant height(cm)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	51.50	55.33	57.53	54.79	52.93	56.67	58.73	56.11
	45	54.67	59.00	61.00	58.22	56.93	61.50	63.67	60.70
	60	57.83	62.33	65.00	61.72	60.33	64.67	67.83	64.29
Mean		54.67	58.89	61.18	58.24	56.73	60.94	63.41	60.36
Sids-12	30	53.00	57.00	59.67	56.57	53.83	57.33	61.50	57.56
	45	56.00	60.67	64.00	60.22	57.50	62.67	65.93	62.03
	60	58.00	64.67	69.00	63.89	59.17	64.67	70.33	64.72
Mean		55.67	60.78	64.22	60.22	56.83	61.56	65.92	61.44
Mean for N-rate	30	52.25	56.17	58.60	55.67	53.38	57.00	60.12	56.83
	45	55.33	59.83	62.50	59.22	57.22	62.08	64.80	61.37
	60	57.92	63.50	67.00	62.81	59.75	64.67	69.08	64.50
Mean		55.17	59.83	62.70	59.23	56.78	61.25	64.68	60.90
L.S.D. at 5% for									
Cultivars (V)			1.04				N.S		
Nitrogen (N)			0.31				0.45		
Amino acids (A)			0.22				0.40		
V × N			N.S				N.S		
V × A			0.32				0.57		
N × A			0.39				0.69		
V × N × A			0.55				N.S		

Table 3: Effect of nitrogen fertilization and amino acids spraying on number of leaves/plant of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Number of leaves/Plant							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	9.00	10.00	11.33	10.11	9.47	10.73	12.17	10.79
	45	10.00	13.00	14.00	12.33	11.00	13.60	14.73	13.11
	60	12.00	15.00	16.00	14.33	12.93	14.83	16.67	14.81
Mean		10.33	12.67	13.78	12.26	11.13	13.06	14.52	12.90
Sids-12	30	9.00	11.00	12.00	10.67	10.07	11.97	12.90	11.64
	45	11.00	14.00	15.67	13.56	12.10	14.43	16.63	14.39
	60	13.00	14.67	15.33	14.33	13.90	15.53	16.83	15.42
Mean		11.00	13.22	14.33	12.85	12.02	13.98	15.46	13.82
Mean for N-rate	30	9.00	10.5	11.67	10.39	9.77	11.35	12.53	11.22
	45	10.50	13.50	14.83	12.94	11.55	14.02	15.68	13.75
	60	12.50	14.83	15.67	14.33	13.42	15.18	16.75	15.12
Mean		10.67	12.94	14.06	12.56	11.58	13.52	14.99	13.36
L.S.D. at 5% for									
Cultivars (V)			N.S				0.30		
Nitrogen(N)			0.61				0.72		
Amino acids (A)			0.28				0.31		
V × N			N.S				N.S		
V × A			N.S				N.S		
N × A			0.49				0.53		
V × N × A			0.70				N.S		

3 – Effect of amino acids:

It is obvious from the same table that foliar spraying of amino acids significantly increased all growth characters of wheat plant compared to untreated plants in both seasons. Application of amino acids were improved growth which may be due to their role in raising cell division and enlargement and forming more tissues and organs. The beneficial effect of amino acids on wheat growth characters were also reported by Salwa and Osama (2014).

Table 4: Effect of nitrogen fertilization and amino acids spraying on number of tillers/plant of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Number of tillers/plant							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	1.67	2.00	2.33	2.00	1.97	2.40	2.83	2.40
	45	2.17	2.50	3.00	2.56	2.50	2.93	3.50	2.98
	60	2.83	3.07	3.40	3.10	3.10	3.33	3.77	3.40
Mean		2.22	2.52	2.91	2.55	2.52	2.89	3.37	2.93
Sids-12	30	1.77	2.17	2.50	2.14	2.03	2.50	3.17	2.57
	45	2.27	2.53	3.10	2.63	2.60	3.07	3.27	2.98
	60	2.97	3.20	3.53	3.23	3.30	3.60	3.83	3.58
Mean		2.33	2.63	3.04	2.67	2.64	3.06	3.42	3.04
Mean for N-rate	30	1.71	2.08	2.42	2.07	2.00	2.45	3.00	2.48
	45	2.22	2.52	3.05	2.59	2.55	3.00	3.38	2.98
	60	2.90	3.13	3.47	3.17	3.20	3.47	3.80	3.49
Mean		2.28	2.58	2.98	2.61	2.58	2.97	3.39	2.98

L.S.D. at 5% for		
Cultivars (V)	0.06	N.S
Nitrogen(N)	0.22	0.21
Amino acids (A)	0.33	0.28
V × N	N.S	N.S
V × A	N.S	N.S
N × A	N.S	N.S
V × N × A	N.S	N.S

Table 5: Effect of nitrogen fertilization and amino acids spraying on flag leaf area(cm^2) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Flag leaf area (cm^2)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	22.40	23.27	24.17	23.28	22.57	23.83	24.80	23.73
	45	22.77	24.37	25.50	24.21	23.23	25.10	26.00	24.78
	60	24.17	26.37	27.53	26.02	24.67	26.73	28.07	26.49
Mean		23.11	24.67	25.73	24.50	23.49	25.22	26.29	25.00
Sids-12	30	23.03	24.53	25.47	24.34	23.53	24.77	25.87	24.72
	45	24.17	25.80	27.03	25.67	24.50	26.00	27.50	26.00
	60	25.60	27.30	28.30	27.07	26.00	27.43	29.00	27.48
Mean		24.27	25.88	26.93	25.69	24.68	26.07	27.46	26.07
Mean for N-rate	30	22.72	23.90	24.82	23.81	23.05	24.30	25.33	24.23
	45	23.47	25.08	26.27	24.94	23.87	25.55	26.75	25.39
	60	24.88	26.83	27.91	26.54	25.33	27.08	28.53	26.98
Mean		23.69	25.27	26.33	25.10	24.08	25.64	26.87	25.53

L.S.D. at 5% for		
Cultivars (V)	0.22	0.31
Nitrogen(N)	0.13	0.32
Amino acids (A)	0.13	0.16
V × N	0.18	N.S
V × A	N.S	N.S
N × A	0.22	0.28
V × N × A	0.32	N.S

4 – Interaction effects:

The results in Tables (2, 3, 4 and 5) indicate that the significant interaction effect between cultivars and nitrogen fertilizer rates were only found on flag leaf area in the first season. The interaction between cultivars and amino acids significantly affected plant height in both seasons. Concerning, the interaction between nitrogen fertilizer levels and amino acids there were significant on plant height, number of

leaves/plant and flag leaf area in both seasons. The interaction among cultivars, nitrogen fertilizer rates and amino acids had significant effects on plant height, number of leaves/plant and flag leaf area in the first season only.

B- Yield and yield components:

1- Performance of cultivars:

Results presented in Tables (6, 7, 8, 9 and 10) indicate that wheat cultivars Sids-1 and Sids-12 differed significantly in number of grains/spike in first season and 1000-grains weight in the second season only. Sids-12 had higher all characters under study than Sids-1 cultivar**.** The different behavior of varieties observed in the studied characters might reflect the differential expressivity of certain genes during autogenetic processes**.** These results agreement with those obtained by El-Nagar (2003) and Bakry *et al.* (2013).

Table 6: Effect of nitrogen fertilization and amino acids spraying on number of spikes/m^2 of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Number of spikes/m^2							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	265.00	290.00	311.67	288.89	269.66	295.33	316.00	293.67
	45	290.00	314.00	332.67	312.22	295.00	318.33	338.33	317.22
	60	311.00	335.00	345.00	330.33	315.67	340.00	350.00	335.22
Mean		288.67	313.00	329.78	310.48	293.44	317.89	334.78	315.37
Sids-12	30	268.00	292.33	306.67	289.00	274.00	296.33	312.00	294.11
	45	292.67	315.33	337.33	315.11	296.67	320.00	342.00	319.56
	60	313.66	338.33	347.67	333.22	318.33	342.33	353.33	338.00
Mean		291.44	315.33	330.56	312.44	296.33	319.56	335.78	317.22
Mean for N-rate	30	266.50	291.17	309.17	288.94	271.83	295.83	314.00	293.89
	45	291.33	314.67	335.00	313.67	295.83	319.16	340.17	318.39
	60	312.33	336.67	346.33	331.78	317.00	341.17	351.67	336.61
Mean		290.06	314.17	330.17	311.46	294.89	318.72	335.28	316.30
L.S.D. at 5% for									
Cultivars (V)				N.S				N.S	
Nitrogen(N)				2.24				2.10	
Amino acids (A)				2.04				2.19	
V × N				N.S				N.S	
V × A				N.S				N.S	
N × A				3.54				3.80	
V × N × A				N.S				N.S	

2 – Effect of nitrogen fertilizer:

As shown in Tables (6, 7, 8, 9 and 10) results indicated that increasing nitrogen rates from 30, 45 to 60 kg N /fed. significantly increased yield and yield components in both growing seasons**.** Maximum values of number of spikes/m^2, number of grains/spike, 1000-grains weight, grain yield (ton/fed.) and straw yield (ton/fed.) were observed with adding 60 kg N /fed. The increase in these characters with the increase of nitrogen level might due to the role of nitrogen in activating the growth and yield components. This reflects the important of nitrogen in building up the photosynthetic area of wheat plants and consequently accumulation of more dry matter, which is reflected in grain yield and its components. The response of wheat plants to the nitrogen application may be due to the increase of available (N) in soil. These results are in line with those obtained by Abou-Salama *et al.*(2000) and Gehan *et al.* (2011).

3 – Effect of amino acids:

Data in Tables (6, 7, 8, 9 and 10) reveal that foliar spraying wheat plants with amino acids significantly increased yield and its components (number of spikes/m^2, number of grains/spike, 1000-grains weight and straw yield ton/fed.) in both seasons. The highest mean values are recorded in plants treated with amino acids 5 ml/L. The positive effect of amino acids on yield and its components may be attributed the importance of amino acids came from their widely use for the biosynthesis of a large variety of

nonproteinic nitrogenous materials, i.e. pigments, vitamins, coenzymes, purine and pyrimidine bases. Studies have proved that amino acids can directly or indirectly influence the physiological activities in plant growth and yield (Mohamed 2006). These results are similar to those reported by Mohammad *et al.* (2013) and Salwa and Osama (2014).

Table 7: Effect of nitrogen fertilization and amino acids spraying on number of grains/spike of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Number of grains/spike							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	45.67	49.00	51.33	48.67	46.83	50.67	52.83	50.11
	45	49.33	51.50	53.43	51.42	51.17	53.33	55.00	53.17
	60	53.00	55.00	57.50	55.17	54.67	57.33	59.00	57.00
Mean		49.33	51.83	54.09	51.75	50.89	53.78	55.61	53.43
Sids-12	30	46.00	49.50	51.73	49.08	47.33	51.00	53.33	50.56
	45	49.67	51.87	53.73	51.76	51.50	53.33	55.67	53.50
	60	53.27	55.30	57.90	55.49	55.00	57.17	59.67	57.28
Mean		49.64	52.22	54.46	52.11	51.28	53.83	56.22	53.78
Mean for N-rate	30	45.83	49.25	51.53	48.87	47.08	50.83	53.08	50.33
	45	49.50	51.68	53.58	51.59	51.33	53.33	55.33	53.33
	60	53.13	55.15	57.70	55.33	54.83	57.25	59.33	57.14
Mean		49.49	52.03	54.27	51.93	51.08	53.81	55.92	53.60
L.S.D. at 5% for									
Cultivars (V)		0.09				N.S			
Nitrogen(N)		0.62				0.60			
Amino acids (A)		0.35				0.45			
V × N		N.S				N.S			
V × A		N.S				N.S			
N × A		0.61				0.77			
V × N × A		N.S				N.S			

Table 8: Effect of nitrogen fertilization and amino acids spraying on 1000-grains weight (g) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		1000-grains weight (g)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	38.10	39.23	41.60	39.64	39.00	40.60	42.90	40.83
	45	39.83	41.63	42.83	41.43	41.17	43.00	43.83	42.67
	60	41.00	36.93	44.17	40.70	42.37	44.17	45.73	44.09
Mean		39.64	39.27	42.87	40.59	40.84	42.59	44.16	42.53
Sids-12	30	38.23	39.40	41.87	39.83	40.00	41.40	43.33	41.58
	45	40.07	41.87	43.10	41.68	41.50	43.33	44.50	43.11
	60	41.23	43.07	44.37	42.89	42.83	44.77	45.93	44.51
Mean		39.84	41.44	43.11	41.47	41.44	43.17	44.59	43.07
Mean for N-rate	30	38.17	39.32	41.73	39.74	39.50	41.00	43.12	41.21
	45	39.95	41.75	42.97	41.56	41.33	43.17	44.17	42.88
	60	41.12	40.00	44.27	41.79	42.60	44.47	45.83	44.30
Mean		39.74	40.36	42.99	41.03	41.14	42.88	44.37	42.80
L.S.D. at 5% for									
Cultivars (V)		N.S				0.24			
Nitrogen(N)		N.S				0.32			
Amino acids (A)		1.57				0.17			
V × N		N.S				N.S			
V × A		N.S				N.S			
N × A		N.S				0.29			
V × N × A		N.S				N.S			

4 – Interaction effects:

Results in Tables (6, 7, 8, 9 and 10) indicated that the interaction between (cultivars x nitrogen), (cultivars x amino acids) and (cultivars x nitrogen x amino acids) had no significant effect on yield and its components in both seasons. The interaction between nitrogen rates and amino acids were significant on number of spikes/m^2 and number of grains/spike in both seasons and 1000-grains weight in the second season only.

Table 9: Effect of nitrogen fertilization and amino acids spraying on grain yield (ton/fed.) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Grain yield (ton/fed.)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	1.96	2.16	2.37	2.16	1.76	2.29	2.50	2.18
	45	2.18	2.45	2.59	2.41	2.35	2.59	2.69	2.54
	60	2.65	2.59	2.74	2.66	2.45	2.69	2.80	2.65
Mean		2.26	2.40	2.57	2.41	2.18	2.52	2.67	2.46
Sids-12	30	1.98	2.19	2.33	2.17	2.12	2.29	2.46	2.29
	45	2.21	2.45	2.63	2.43	2.33	2.58	2.75	2.55
	60	2.36	2.63	2.81	2.60	2.49	2.73	2.92	2.71
Mean		2.18	2.42	2.59	2.40	2.31	2.53	2.71	2.52
Mean for N-rate	30	1.97	2.17	2.35	2.16	1.94	2.29	2.48	2.24
	45	2.20	2.45	2.61	2.42	2.34	2.58	2.72	2.55
	60	2.50	2.61	2.77	2.63	2.47	2.71	2.86	2.68
Mean		2.22	2.41	2.58	2.40	2.25	2.53	2.69	2.49

L.S.D. at 5% for		
Cultivars (V)	N.S	N.S
Nitrogen(N)	0.25	0.20
Amino acids (A)	0.23	0.21
V × N	N.S	N.S
V × A	N.S	N.S
N × A	N.S	N.S
V × N × A	N.S	N.S

Table 10: Effect of nitrogen fertilization and amino acids spraying on straw yield (ton/fed.) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Straw yield (ton/fed.)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	2.17	2.48	3.06	2.57	2.29	2.50	2.64	2.48
	45	2.49	2.69	2.85	2.68	2.52	2.74	2.87	2.71
	60	2.77	2.86	2.93	2.85	2.63	2.85	2.97	2.82
Mean		2.48	2.68	2.95	2.69	2.48	2.70	2.83	2.66
Sids-12	30	2.37	2.56	2.70	2.54	2.34	2.54	2.65	2.51
	45	2.53	2.70	2.86	2.70	2.51	2.75	2.87	2.71
	60	2.79	2.88	2.94	2.87	2.65	2.87	2.98	2.83
Mean		2.56	2.71	2.83	2.70	2.50	2.72	2.83	2.68
Mean for N-rate	30	2.27	2.52	2.88	2.56	2.32	2.52	2.65	2.49
	45	2.51	2.70	2.86	2.69	2.52	2.74	2.87	2.71
	60	2.78	2.87	2.94	2.86	2.64	2.86	2.98	2.82
Mean		2.52	2.70	2.89	2.70	2.49	2.71	2.83	2.68

L.S.D. at 5% for		
Cultivars (V)	N.S	N.S
Nitrogen(N)	0.15	0.03
Amino acids (A)	0.24	0.03
V × N	N.S	N.S
V × A	N.S	N.S
N × A	N.S	N.S
V × N × A	N.S	N.S

C-Grain quality:-

1- Performance of cultivars:

Tables (11 and 12) showed that protein and carbohydrate percentage in grain were not significantly affected by cultivars in 2014/2015 and 2015/2016 seasons. These results agree with those obtained by El-Desoky and El-Far (1999) and Mervat *et al.* (2013).

2 – Effect of nitrogen fertilizer:

Illustrated data in Tables **(**11 and 12**)** clearly indicated that nitrogen fertilizer rates had significantly increased protein and carbohydrate percentage in both seasons. The highest values were obtained when nitrogen was applied at a rate of 60 kg N/fed. during 2014/2015 and 2015/2016 seasons. This indicates the target of wheat nitrogen fertilization in highly responsive soil should not be yield only but it should put into account grain protein and carbohydrate content. Because wheat provides more protein than any other cereal crops globally. These results are in accordance with those found by Bayoumi and El-Demardash (2008) and Gehan *et al.* (2011).

3 – Effect of amino acids:

Presented data in Tables **(**11 and 12**)** revealed that spraying wheat plants with amino acids significantly increased protein and carbohydrate percentage in both seasons. The highest mean values are recorded in plants treated with amino acids 5 ml/L. These results are in accordance with this found by Salwa and Osama (2014).

4 – Interaction effects:

The presented data in Tables **(**11 and 12**)** revealed that protein and carbohydrate percentage were not significantly affected by all possible interactions, except the interaction between nitrogen rates and amino acids were significant on protein in the second season only**.**

Table 11: Effect of nitrogen fertilization and amino acids spraying on protein(%) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Protein(%)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	8.26	9.25	9.89	9.13	9.13	9.69	9.95	9.59
	45	9.15	10.21	10.52	9.96	9.58	10.55	11.09	10.41
	60	9.85	11.15	11.62	10.88	9.97	11.10	11.97	11.01
Mean		9.09	10.20	10.68	9.99	9.56	10.45	11.00	10.34
Sids-12	30	8.53	9.58	9.85	9.32	9.13	9.72	10.11	9.65
	45	9.46	10.55	11.75	10.59	9.59	10.59	11.11	10.43
	60	10.22	11.45	11.91	11.19	9.98	11.16	11.98	11.04
Mean		9.40	10.53	11.17	10.37	9.57	10.49	11.07	10.37
Mean for N-rate	30	8.40	9.41	9.87	9.23	9.13	9.71	10.03	9.62
	45	9.31	10.38	11.14	10.27	9.59	10.57	11.10	10.42
	60	10.04	11.30	11.77	11.04	9.97	11.13	11.98	11.03
Mean		9.25	10.36	10.92	10.18	9.56	10.47	11.04	10.36

L.S.D. at 5% for		
Cultivars (V)	N.S	N.S
Nitrogen(N)	0.57	0.11
Amino acids (A)	0.72	0.12
V × N	N.S	N.S
V × A	N.S	N.S
N × A	N.S	0.20
V × N × A	N.S	N.S

Table 12: Effect of nitrogen fertilization and amino acids spraying on carbohydrate(%) of two wheat cultivars in 2014/2015 and 2015/2016 seasons.

Characters		Carbohydrate(%)							
Seasons		2014/2015				2015/2016			
Cultivars	N-rate (kg/fad.)	Amino acids			Mean	Amino acids			Mean
		A_0	A_1	A_2		A_0	A_1	A_2	
Sids-1	30	53.15	55.45	56.55	55.05	53.63	55.71	56.82	55.39
	45	56.29	58.45	59.52	58.09	55.50	58.73	59.96	58.06
	60	58.15	59.83	61.79	59.92	58.22	59.69	61.74	59.88
Mean		55.87	57.91	59.29	57.69	55.78	58.04	59.51	57.78
Sids-12	30	53.59	55.28	57.37	55.41	53.76	55.78	56.92	55.49
	45	55.72	58.51	59.96	58.07	55.91	58.71	59.98	58.20
	60	58.26	60.89	61.92	60.36	58.31	59.69	61.77	59.92
Mean		55.86	58.23	59.75	57.95	55.99	58.06	59.56	57.87
Mean for N-rate	30	53.37	55.37	56.96	55.23	53.69	55.75	56.87	55.44
	45	56.01	58.48	59.74	58.08	55.70	58.72	59.97	58.13
	60	58.21	60.36	61.86	60.14	58.27	59.69	61.76	59.90
Mean		55.86	58.07	59.52	57.82	55.89	58.05	59.53	57.83
L.S.D. at 5% for									
Cultivars (V)			N.S				N.S		
Nitrogen(N)			1.80				0.44		
Amino acids (A)			2.09				0.63		
V × N			N.S				N.S		
V × A			N.S				N.S		
N × A			N.S				N.S		
V × N × A			N.S				N.S		

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