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EFFECT OF NITROGEN FERTILISATION LEVELS ON SOME WHEAT CULTIVARS

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Introduction

Increasing wheat productivity under Egyptian conditions is one of the main targets of wheat agronomists. The yield of wheat is a function of many factors among them the cultivars and nitrogen fertilisation being the most important ones.

Mosalem (1993) and Khattab (1994) reported that wheat cultivars Giza 164, Sakha 69 and Giza 163 were superior to the rest of the studied genotypes in most major characters which affected grain yield such as flag leaf area, number of spike lets and grains/spike, grain weight/spike and 1000-grain weight. While comparing Sids cultivars with Giza 163, Giza 164 and Sakha 69, Hassanein et al (1997) and El-Karamity (1998) indicated that Sids cultivars surpassed Giza 163, Giza 164 and Sakha 69 in yield components.

Grain and straw yields with Sids 8 ranked first, followed by Sids 7 and Sids 6 cultivars, while plant height and number of tillers/plant took reverse trend. Salem (1999) indicated that Sids 6 gave the highest grain and protein yield, while Sids 4 gave the highest straw yield. Sharshar et al (2000) reported that, wheat cultivars significantly differed in grain yield and most of measured traits. Moreover, the highest number of spike lets per spike and grain yield/fed was recorded from Sakha 69 wheat cultivar.

Nitrogen is the most important plant nutrient needed to obtain high wheat yields in Egypt. Mosalem (1993), Zahran and Mosalem (1993), Darwich (1994), Essa (1996) and Zahran et al (1997) reported that plant height, flag leaf area, tillers number and dry weight per unit area of wheat were increased with increasing N level. Several investigators (Darwich, 1994; Essa, 1996; Mostafa et al., 1997; Mosalem et al 1997, Sorour et al., 1998 and Sobh et al. (2000) reported a beneficial effect of nitrogen application on wheat. They reported that numbers of tillers and spikes/m^2, plant height, spike length, number of spike lets and grains/spike, grain and straw yields of wheat increased with increasing N level.

Therefore, the objectives of this investigation were to study the effect of nitrogen levels on growth, yield and yield components of three wheat cultivars (*Triticum aestivum* L.) namely Sakha 69, Gemmeiza 3 and Sids 4.

Materials and Methods

The present study was carried out at Gemmeiza Agricultural Research Station, A.R.C., El Gharbia Governorate, Egypt, during the two successive seasons 1996/97 and 1997/98.

The experiment layout was a split plot design with four replications. This experiment included 12 treatments. Three cultivars i. e., Sakha 69 (S. 69), Gemmeiza 3 (G.3) and Sids 4 randomly distributed in main plot and the four nitrogen levels (50, 70, 90 and 110 kg N/feddan) were allocated randomly in the sub plot. The area of each sub plot was 10.5 m^2 (3.0 m wide and 3.5 m in length). The sowing was done using drill hand machine on 20 November in the first season and 25 November in the second season. The harvested area of sub plot was 8.4 m^2 (2.4 m in width and 3.5 m in length) to determine yield of grains and straw.

The amount of nitrogen was divided into two portions; one being applied immediately before the first irrigation and the rest was applied before the second irrigation. Nitrogen was added in the form of urea (46% N).

The preceding crop was cotton in both seasons. Phosphate fertilizer was applied at the rate of 15.5 kg P_2O_5/fed (100 kg calcium super phosphate) during seedbed preparation. Soil structure and chemical analysis of the experimental field are presented in Table 1.

Table 1. Mechanical and chemical analysis of experimental field soils (0-30 cm soil depth).

Variable	Mechanical analysis		Variable	Chemical analysis	
	1996/97	1997/98		1996/97	1997/98
Coarse sand %	2.20	2.70	Soil reaction (pH)	7.7	8.0
Fine sand %	15.20	14.90	Organic matter %	2.10	1.77
Silt %	34.20	33.30	Available N ppm	34.8	36.4
Clay %	48.40	49.10	Available P ppm	6.8	6.2
Soil texture class	Clay	Clay	Available K ppm	450.0	430.0

The following characteristics were studied:

A- Growth attributes

Growth analysis was determined at 15-day intervals. Random samples of wheat plants were collected from ¼ m^2 at four sampling dates; 77, 92, 107 and 122 days after sowing, to determine dry matter production per m^2 and leaf area index (LAI).

B- Yield and yield attributes

At harvest, plant height (cm) was measured and from thirty random spikes from each sub plot, the following characters were determined: spike length (cm), number of spike/spike, number and weight of grains/spike and 1,000-grain weight (g).

From the harvest area (8.4 m^2) the grain and straw yield (kg/plot) were reported and converted into ardab/fed and ton/fed, respectively (ardab = 150 kg and Feddan = 4,200 m^2). The micro Kjeldahl method was used to determine the total nitrogen in the grain and multiplied by 5.75 to obtain the percentage of crude protein according to A.O.A.C. (1980).

Statistical analysis

All the data collected were subjected to statistical analysis of variance as described by Gomez and Gomez (1984). The mean values were compared according to Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

A. Growth attributes

Effect of cultivars

All cultivars differ significantly in dry matter accumulation, however, Gemmeiza 3 had significantly greater values than did the two other cultivars (Tables 2 and 3). Sids 4 was inferior to either of the two other cultivars in dry matter production. This was true in all sampling dates in both seasons, except at the age of 92 days in the first season.

Leaf area index was significantly different at all growth stages in 1996/97 season with Sids 4 was superior to the other two cultivars in this respect. At the age of 122 days Gemmeiza 3 and Sids 4 were significantly higher in leaf area index than Sakha 69.

However, in 1997/98 leaf area index values were not significantly different in the first two stages. At the third and fourth stages Sids 4 was significantly higher than Sakha 69 and Gemmeiza 3, which were not different from each other. Sadek (1990) and Abou Ahmed (1991) had previously obtainined similar results.

Table 2. Dry matter accumulation (g/m^2) of three wheat cultivars as influenced by nitrogen fertilisation levels in 1996/97 and 1997/98 seasons.

Days after sowing	Cultivars (V)				Nitrogen Levels, kg N/fed (N)					Inter-action V xN
	S. 69	G. 3	Sids 4	Sig	50	70	90	110	Sig	
1997/98 season										
77	77.9 b	90.5 a	66.1 c	**	71.1 d	74.1 d	80.1 b	87.5 a	**	**
92	236.1 a	226.7 b	165.3 c	**	188.9 c	192.2 c	218.6 b	237.9 a	**	**
107	400.2b	500.2 a	358.1 c	**	373.5 d	402.3 c	423.4 b	479.3 a	**	**
122	462.6 b	522.6 a	377.3 c	**	379.0 d	425.5 c	475.9 b	526.3 a	**	**
1998/99 season										
77	95.0 b	122.6 a	85.5 c	**	91.3 c	95.5 bc	99.9 b	117.5 a	**	**
92	295.2b	319.7 a	221.6 c	**	242.7 d	252.2 c	287.8 b	332.6 a	**	**
107	361.0 b	475.7 a	349.8 c	**	349.5 d	374.1 c	397.8 b	460.5 a	**	**
122	431.9 b	574.6 a	396.1 c	**	390.4 d	447.0 c	481.8 b	551.0 a	**	**

*, ** and n.s indicate P<0.05, P< 0.01 and not significant, respectively. Means designated by the same letter are not significantly different at 5% level according to Duncan's Multiple Range Test 1955.

Table 3. Leaf Area Index of three wheat cultivars as influenced by nitrogen fertilisation levels in 1996/97 and 1997/98 seasons.

Days after sowing	Cultivars (V)				Nitrogen Levels, kg N/fed (N)					Inter-action V x N
	S. 69	G. 3	Sids 4	Sig	50	70	90	110	Sig	
1996/97 season										
77	4.32 ab	3.80 b	5.28 a	**	3.76 b	4.38 ab	4.64 a	5.08 a	*	n.s
92	4.30 b	5.30 ab	6.10 a	**	4.68	5.25	5.34	5.66	n.s	n.s
107	4.77 ab	4.47 b	5.66 a	**	4.32 b	4.99 a	5.20 a	5.35 a	*	n.s
122	3.79 b	4.66 a	5.37 a	**	4.13	4.62	4.70	4.98	n.s	n.s
1997/98 season										
77	4.48	4.89	5.25	n.s	4.59	4.66	4.95	5.29	n.s	n.s
92	5.18	5.77	6.90	n.s	5.61	5.84	6.04	6.32	n.s	n.s
107	4.28 b	4.72 b	5.78 a	**	4.54 b	4.81 ab	5.12 a	5.24 a	*	*
122	4.52 b	4.49 b	5.52 a	*	4.41	4.71	5.04	5.20	n.s	n.s

Effect of nitrogen levels

Increasing nitrogen rates from 70 to 110 kg N/fed resulted in progressive increase in dry matter accumulation at all sampling dates in both seasons. The highest values were obtained at maximum nitrogen rate and the lowest ones at minimum nitrogen rate. At the age of 107 days, increasing nitrogen rate over 50 kg N/fed resulted is significant higher leaf area index values (Tables 2 and 3). These results could be substantiated with those obtained by Sadek (1990), Abou Ahmed (1991), Mosalem (1993), Zahran et al (1997) and Sorour et al (1998).

Effect of interaction

The interaction between cultivars and nitrogen levels had a significant effect on dry matter accumulation in all growth stages in two seasons (Tables 2 and 3). The effect of increasing nitrogen levels up to 110 kg N/fed on dry matter accumulation was more obvious in the cultivar Gemmeiza 3 compared with the other two cultivars. While, the interaction among the two factors studied in both seasons was insignificant on leaf area index, except at the third sample in the second season. It is clear from the data that the largest leaf area index was recorded by wheat cultivars Sids 4 grown under 110 kg N/fed.

B- Yield and Yield components

Effect of cultivars

All cultivars differed significantly in plant height with Gemmeiza 3 exhibiting the highest and Sids 4 the lowest values in both seasons (Tables 4 and 5). Sakha 69 and Gemmeiza 3 did not differ significantly in spike length in both seasons, but both produced significantly smaller spikes than did Sids 4. Sakha 69 and Sids 4 were not different from each other in number of spike lets/ spike but both were superior to Gemmeiza 3 in this respect in both seasons. Sids 4 was superior to the other two cultivars in number of grains / spike in both seasons.

Cultivars did not differ in grain weight /spike in the first season. But they did differ significantly in the second season with Sakha 69 produced significantly lower grain weight/spike than the other two cultivars, which were not different. All cultivars differ significantly in 1000- grain weight in the two seasons with Gemmeiza 3 was heaviest, that of

Sakha 69 was lightest and Sids 4 was intermediate. Sakha 69 and Gemmeiza 3 did not differ in number of spikes /m^2 but both significantly exceeded that of Sids 4 in the two seasons.

Table 4. Yield and its components of three wheat cultivars as influenced by nitrogen levels in 1996/97 season.

Variables	Cultivars (V)				Nitrogen Levels, kg N/fed (N)					VxN
	S. 69	G. 3	Sids 4	Sig	50	70	90	110	Sig	
Plant height (cm)	113.1b	122.2a	104.4c	**	109.8b	112.4ab	114.7a	116.1a	*	*
Spike length (cm)	12.1b	12.2b	16.3a	**	13.1d	13.4c	13.6b	14.0a	*	*
Spike lets No./spike	21.8a	20.2b	21.0ab	*	20.3c	20.8bc	21.2ab	21.6a	**	n.s
Grains No./spike	52.4b	56.5b	69.3a	**	57.7b	58.4ab	60.4ab	60.9a	*	*
Grain wt./spike (g)	3.17	3.38	3.40	n.s	3.118b	3.27ab	3.41ab	3.46a	*	n.s
1000-grain wt. (g)	49.7c	71.5a	58.8b	**	61.6a	60.6ab	59.5ab	58.3b	*	n.s
No. of spikes/m^2	383.8a	415.9a	236.3b	**	316.5b	326.7b	357.8ab	380.3a	*	n.s
Grain yield, ard/Fed	17.67b	18.69a	14.38c	**	14.96c	16.84b	17.65ab	18.21a	**	**
Straw yield, ton/Fed	5.31a	5.54a	4.34b	*	4.73b	4.88b	5.25a	5.40a	*	**
Protein percentage	12.2b	12.4b	14.1a	*	12.4b	12.7ab	13.0ab	13.4a	*	*

*,** an d n.s indicate P<0.05, P< 0.01 and not significant, respectively. Means designated by the same letter are not significantly different at 5% level according to Duncan's Multiple Range Test 1955.

The straw yield of Sakha 69 and Gemmeiza 3 did not differ significantly but both exceeded that of Sids 4 (Tables 4 and 5). This increase can be attributed to taller plants. Sakha 69 and Gemmeiza 3 did not differ significantly in protein percentage but Sids 4 significantly surpassed that of the first two cultivars (Tables 4 and 5). The superiority of the third cultivar over the first two cultivars in seed protein content reveals that higher proportions of metabolites were available for synthesis of protein in the third cultivar there by increasing protein percentage.

Table 5. Yield and its components of three wheat cultivars as influenced by nitrogen levels in 1997/98 season.

Variables	Cultivars (V)				Nitrogen Levels, kg N/fed (N)				VxN	
	S. 69	G. 3	Sids 4	Sig	50	70	90	110	Sig	
Plant height (cm)	110.2b	123.3a	111.4b	**	112.3 b	113.8 b	115.9ab	117.8a	*	*
Spike length (cm)	11.0b	11.2b	15.9a	**	12.4	12.6	12.8	13.0	n.s	n.s
Spike lets No./spike	20.9ab	19.9b	21.8a	*	20.0 c	20.4bc	21.2ab	21.9a	*	n.s
Grains No./spike	49.1c	55.3b	69.7a	**	54.1 b	57.5ab	59.2ab	61.5a	*	*
Grain wt./spike (g)	2.86b	3.36a	3.39a	*	2.84 c	3.02bc	3.40ab	3.56a	**	*
1000-grain wt. (g)	52.6c	64.0a	55.5b	**	58.2	57.9	57.0	56.6	n.s	n.s
No. of spikes/m^2	385.0a	409.7a	241.6b	**	335.0	339.6	347.5	359.6	n.s	n.s
Grain yield, ard/Fed	18.13a	18.72a	15.50b	*	16.09 b	17.34a	17.99a	18.39a	**	**
Straw yield, ton/Fed	5.70a	5.79a	4.45b	*	4.98 b	5.12 b	5.60a	5.56a	*	**
Protein percentage	12.1b	11.7b	13.4a	*	11.9 b	12.3ab	12.5ab	12.8a	*	*

*,** and n.s indicate P<0.05, P< 0.01 and not significant, respectively. Means designated by the same letter are not significantly different at 5% level according to Duncan's Multiple Range Test 1955.

Gemmeiza 3 out yielded Sakha 69 and Sids 4 while Sids 4 was the poorest yielded of grains in both seasons (Tables 4 and 5). The highest grain yield /fed recorded by Gemmeiza 3 in 1996/97 can be attributed to heaviest 1000- grain weight and higher number of spikes/m^2.

On the other hand, the main contributing factors for highest grain yield in 1997/98 were heavier grain weight/spike, heaviest 1000-grain weight and greater number of spikes /m^2. These results are in harmony with those obtained by Khattab (1994), Hassanein et al (1997), El-Karamity (1998), Salem (1999) and Sharshar et al., (2000).

Effect of nitrogen levels

Nitrogen rates significantly influenced plant height. The tallest plants were obtained at 110 kg N/ fed and the shortest at 50 kg N/fed in both seasons. Other nitrogen rates did not differ from each other in this respect. Spike length was significantly affected by nitrogen rates in 1996/97 only where the longest spike was recorded at highest nitrogen rate and shortest at minimum nitrogen rate.

Number of spike lets /spike, number of grains /spike, grain weight/spike, 1000-grain weight, number of spikes/m^2 and protein percentage were significantly different at the extremes in nitrogen applications. The other two nitrogen rates were not significantly different from each other in the same variables. This trend was true in both seasons.

Differently, the 1000-grain weight and number of spikes /m^2 were significantly affected by nitrogen rates in 1996/97 only. Straw yield /fed was significantly increased at the two highest nitrogen levels compared with those at the two lowest levels which were not different in both seasons. Such straw increase at higher nitrogen rates is probably due to taller plants. Highest grain yield was obtained at 110kg N/fed and lowest at 50kg N/fed. The other two nitrogen rates were not different from each other.

This trend was true in both seasons. The highest grain yield at 110kg N/fed in 1996/97 can be attributed to greatest spike length, number of spike lets /spike, number of grains /spike, number of spikes/m^2, heavier grain weight/ spike and highest protein percentage. On the other hand, the main contributing factors for highest grain yield in 1997/98 were greatest number of spike/spike, number of grains/ spike, grain weight /spike and highest protein percentage.

The poorest grain yield recorded at 50 kg N/fed in 1996/97 can be ascribed to lowest spike length, number of spike/spike, number of grains/ spike, number of spikes/m^2 and lowest protein percentage. The main reasons behind poorest grain yield in 1997/98 can be attributed to lowest spike length, number of grains/spike, grain weight/spike and lowest protein percentage. These results agree with those obtained by Sadek (1990), Abou-Ahmed (1991), Mosalem (1993), Zahran and Mosalem (1993), Darwiche (1994), El-Zein (1994), Eissa (1995), El-Shami et al (1995), Sharshar et al (1995), Essa (1996), Mostafa et al. (1997), Sorour et al (1998), Sharshar et al., (2000) and Sobh et al (2000).

Effect of interactions

The data in Tables (4 and 5) indicated that plant height at harvest time, number of grains/spike, grain and straw yields and protein percentage were significantly affected by the interaction between cultivars and nitrogen levels in both seasons. It was concluded that, the maximum grain yield could be obtained by sowing Gemmeiza 3 wheat cultivar under 90 kg N/fed.

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