

Effect of nitrogen fertilizer and bio-fertilizer on yield and yield components of two wheat cultivars under sandy soil

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ABSTRACT

Two field experiments were carried out during 2014/2015 and 2015/2016 seasons at Wadi El-Rayan Fayoum Governorate, Egypt to study the effect of ammonia gas (82%) and bio-fertilizer on yield and yield components of two wheat cultivars. The results could be summarized as follows: There were significant differences for yield and yield components characters in both seasons owing to varietal differences i.e. plant height (cm), number of tillers/ m², number of spikes/ m², weight of spikes g/ m² and grain index (g), while the differences between cultivars for grain yield (g/ m²), grain yield ton/ fed., straw yield ton / fed., and biological yield ton/ fed., failed to reach significant level at 5% in both seasons. Sohag-4 cultivar gave the higher plant height (cm) and grain index (g). At the same time Sakha-94 gave the best value for the other characters. Nitrogen addition as Ammonia gas (82%) showed a favourable effect on improving wheat yield. Adding Ammonia gas had a significant effect on yield and yield components of wheat compared with control (without ammonia gas) increasing ammonia gas from zero to 90 kg N/ feddan increased yield and yield components of wheat significantly in both seasons. Adding Yeast surpassed Azotobacter significantly on yield and its components of wheat. The interaction between the three order i.e. (wheat cultivars x nitrogen fertilizer, wheat cultivars x bio-fertilizer, nitrogen fertilizer x bio-fertilizer and wheat cultivars x nitrogen fertilizer x bio-fertilizer) were significant. Data illustrated that the best treatment for yield and its component of wheat in the two seasons was Sohag-4 cultivar+ 90 kg N/ fed+ Azotobacter for plant height and Sohag-4 cultivar+ 90 kg N/ fed+ Yeast for grain yield (g/ m²) and grain index (g), while the best treatment for number of tillers/m², number of spikes/m² and weight of spikes (g/m²) was Sakha-94+ 90 kg N/fed+ Yeast.

Key words: Wheat, cultivars, nitrogen, ammonia gas, Azotobacter, Yeast, yield and yield components.

Introduction

Wheat (*Triticum aestivum* L.) is consider one of the most important crops as human food and animal feed. Now, a great attention of several investigators has been directed to increase the productivity of wheat to minimize the gap between production and consumption by increasing the cultivated area and wheat yield per unit area. The total biomass is a result of the integration of metabolic reaction in the plant. Any factor influencing the metabolic activity of the plant at any period of its growth can affect the yield. Metabolic processes in wheat plants are greatly governed by both internal i.e. genetic makeup of the plant and external conditions which namely climatic and edaphically environmental factors. It is obvious that, increasing wheat production per unit area can be achieved by breeding and cultivating the promising wheat cultivars and applying the optimum cultural practices such as suitable fertilizer. There were a significant differences among cultivars (El-Esh, 2007, Zaki *et al*, 2012 and Zaki *et al*, 2016).

Nitrogen is the most limiting factor in crop production and results in higher biomass and protein yields in plant tissue. The efficiency of nitrogen fertilizer increased by using ammonium gas, thus the evaluation the rate of this form to choice the best rate, many investigator reported in this aims (Waseem, *et al*, 2007, El-Gizawy and Salem, 2010 and Zaki *et al*, 2016). Many investigators told that

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biofertilizer (Azotobacter, Yeast) produced significant increment in all yield and yield components characters under study (Zaki *et al*, 2007, Zaki *et al*, 2012 and Zaki *et al*, 2016).

The aim of this investigation was designed to study the effect of Ammonia gas (82%) and bio-fertilizer on yield and yield components of two wheat cultivars under sandy soil.

Materials and Methods

Two field experiments carried out at new land at Wadi El-Rayan, El-Fayoum Governorate, Egypt during 2014/2015 and 2015/2016 seasons. The experiments were conducted to study the effect of nitrogen fertilizer i.e. (ammonia gas 82%) and bio-fertilizer on two wheat cultivars (*Triticum aestivum* L.). Soil samples was taken at depth of 30 cm for mechanical and chemical analysis as described by Chapman and Pratt (1961). The mechanical and chemical of the soil at the experimental site were illustrated in Table (1).

Table 1: Mechanical and chemical analysis of soil at experimental sites (Average of 2015 and 2016 seasons)

Sand (%)	Silt (%)	Clay (%)	Texture	pH	Organic matter O.M.%	Available N ppm	Available K ppm	Available P ppm
73.59	22.47	3.45	Sandy	8.00	0.49	84.00	134.00	12.5

The experimental design was split-split plot design with four replications. Wheat cultivars were allocated randomly in the main plots and nitrogen fertilizer were randomly allocated in sup- plots and bio-fertilizer were allocated in sup-sup plot design.. The size of each plot was 10.5m² (1/400 feddan) 3.5 m long and 3 m wide. Each experiment included sixteen treatments which were the combination among two cultivars and nitrogen fertilizer and bio-fertilizer.

The experimental treatments can be described as follows:

Cultivars:

- 1- Sohag-4
- 2- Sakha-94

Nitrogen fertilizer (Ammonia gas 82%):

- 1- Control
- 2- 30 kg N/ fed.
- 3- 60 kg N/ fed.
- 4- 90 kg N/ fed.

Bio-fertilizer:

- 1- Azotobacter
- 2- Yeast

Potassium fertilizer was applied before sowing at a rate of 50 kg/ fed., in the form of potassium sulphate (48% K₂O). Super phosphate fertilizer (15.5%P₂O₅) was applied before sowing at the rate of 150 kg/ fed. Sowing dates were November 15th and November 20th in both seasons, respectively, while, seeding rate was 70 kg/ fed. The normal agronomic practices of wheat were followed until harvest as recommended by Wheat Research Dep., Agric. Research Centre.

At harvest, 10 plants at random were taken from each plot to determine plant height (cm) and grain index(g),also, one meter was taken from each plot to determine number of tillers/ m², number of spikes/ m², weight of spikes (g/ m²) and grain yield(g/m²). Grain yield (ton/fed), straw yield (ton/fed) and biological yield (ton/fed) was estimated from each plot.

Data obtained were exposed to the proper method of statistical analysis of variance differentiate among means of different as described by Gomez and Gomez (1984). The treatments means were compared using the least significant differences (L.S.D.) test at 5% level of probability. Combined analysis was made from the two growing seasons hence the results of two seasons followed similar trend.

Results and Discussion

Effect of cultivars:

Data in Table (2) indicated that the differences between wheat cultivars in most characters under study i.e. (plant height (cm), number of tillers/ m², number of spikes/ m², weight of spikes (g/m²) and grain index (g)) were significant in both seasons, while grain yield (g/m²), grain yield (ton/fed.), straw yield (ton/fed.) and biological yield (ton/fed.) failed to reach the significant level. The differences between wheat cultivars and differences between genotype concerning partition of dry matter, where wheat cultivar differed carbon equivalent, yield energy per plant and per fed. (Ahmed *et al*, 2009).

These results are in agreement with those obtained by El-Habbasha (2001), Zaki *et al* (2004), Ahmed *et al* (2006), Zaki *et al* (2012), Hassanein *et al* (2013) and Zaki *et al* (2015).

Table 2: Effect of cultivars, nitrogen fertilizer and bio-fertilizer on yield and its components of wheat plants (Average of 2014/2015 and 2015/2016 seasons).

Characters Treatments	Plant height (cm)	No. of tillers (m ²)	No. of spikes (m ²)	Weight of spikes (g/m ²)	Gain yield (g/m ²)	Grain index (g)	Straw yield (ton/ fed.)	Grain yield (ton/ fed.)	Biological (ton/fed.)
Cultivars									
Sohag-4	128.33	477.51	476.30	789.67	544.98	45.98	7.50	4.68	12.19
Sakha- 94	125.31	490.49	485.57	796.56	544.23	43.73	7.50	4.62	12.12
L.S.D. at 5%	0.03	1.71	0.31	0.75	n.s	0.11	n.s	n.s	n.s
Nitrogen fertilizer(Ammonia Gas)									
Control	122.13	464.61	466.34	777.73	528.44	42.20	7.32	4.52	11.84
30 kg/N fed.	125.24	480.10	479.02	789.49	539.48	44.08	7.39	4.56	11.97
60 kg/N fed.	128.24	490.45	485.57	797.93	550.25	45.75	7.62	4.75	12.37
90 kg/N fed.	131.68	500.82	492.81	807.30	560.24	47.57	7.68	4.77	12.44
L.S.D. at 5%	0.09	0.80	0.22	0.60	1.50	0.10	0.13	0.11	0.19
Bio- fertilizer									
Azotobacter	125.96	482.69	476.61	786.57	532.84	44.17	7.47	4.62	12.10
Yeast	127.69	485.30	485.26	799.66	556.36	45.54	7.53	4.68	12.20
L.S.D. at 5%	0.07	0.33	0.18	0.31	0.94	0.07	n.s	0.04	0.09

Effect of nitrogen fertilizer:

Data in Table (2) indicated that all yield and its components characters (plant height (cm), number of tillers/ m², number of spikes/ m², weight of spikes (g/m²), grain yield (g/m²), grain index (g), grain yield (ton/fed.), straw yield (ton/fed.) and biological yield (ton/fed.)) were significantly affected by different rates of ammonia gas. It is clear that increased nitrogen fertilizer from zero to 90 kg N/feddan increased significantly yield and its components. The greatest values of all yield and its components was 90 kg N/feddan followed by 60 and 30 kg N/feddan compared the control (Ahmed *et al*, 2009, Amin, 2011, Zaki *et al*, 2012 and Zaki *et al*, 2016).

Effect of bio-fertilizer:

It is clear from Table (2) that the bio-treatment with Yeast realized significant increase in all yield characters under study, adding Yeast surpassed Azotobacter significantly. This could be attributed to the role of plant phytohormones like IAA, GA and CKS which promote plant growth, cell division, breaking the special dominances, hence encouraging the photosynthesis and assimilates accumulation (El-Khawas, 1990; Hosam El-Din, 2007 and Zaki *et al*, 2012).

Effect of interaction between wheat cultivars and nitrogen fertilizer:

It is clear from Table (3) that the interaction between wheat cultivars and ammonia gas fertilizer was significant in all yield characters in both seasons. Data in Table (3) illustrated that the most effective treatment for number of tillers/ m², number of spikes/ m², weight of spikes (g/m²) and grain yield (g/m²) was Sakha-94 cultivar +90 kg N/feddan (ammonia gas), while the best treatment for plant height (cm), grain index (g) and straw yield ton/feddan was Sohag-4 cultivars +90 kg N/feddan, while the interaction failed to reach the significant level for grain yield ton/ feddan and biological yield ton/ feddan. These results were in accordance with those obtained by Hassanein *et al* (2001) and Zaki *et al* (2016).

Table 3: Effect of interaction between cultivars x nitrogen fertilizer on yield and its components of wheat plants (Average of 2014/2015 and 2015/2016 seasons).

Treatments	Characters	Plant height (cm)	No. of tillers (m ²)	No. of spikes (m ²)	Weight of spikes (g/m ²)	Gain yield (g/m ²)	Grain index (g)	Straw yield (ton/fed)
Cultivars x Nitrogen fertilizer(Ammonia Gas)								
Sohag-4	Control	123.16	461.14	465.60	777.38	534.17	43.36	7.19
	30 kg/N fed.	126.70	473.51	473.46	784.54	540.69	45.46	7.41
	60 kg/N fed.	129.72	481.87	480.10	794.11	548.23	46.67	7.66
	90 kg/N fed.	133.55	493.51	486.05	802.66	556.82	48.46	7.74
Sakha- 94	Control	121.11	468.08	467.08	778.08	522.71	40.67	7.45
	30 kg/N fed.	123.78	486.69	484.57	794.45	538.26	42.71	7.36
	60 kg/N fed.	126.56	499.04	491.04	801.76	552.27	44.83	7.58
	90 kg/N fed.	129.81	508.14	499.57	811.94	563.67	46.69	7.61
L.S.D. at 5%		0.13	1.13	0.31	0.85	2.12	0.14	0.19

Effect of interaction between wheat cultivars and bio-fertilizer:

The effect of interaction between wheat cultivars and bio-fertilizer (Azotobacter or Yeast) on yield and its components are reported in Table (4). The results revealed that, the highest number of tillers/m², number of spikes/ m² and weight of spikes g/ m² were obtained from planting Sakha-94 wheat cultivar with Yeast, while the highest plant height (cm), grain yield (g/m²) and grain index (g) were obtained from Sohag-4 cultivar with Yeast inoculation. These results are in harmony with those obtained by Hosam El-Din (2007), Zaki *et al* (2007) and Zaki *et al* (2012).

Table 4: Effect of interaction between cultivars x bio-fertilizer on yield and its components of wheat plants (Average of 2014/2015 and 2015/2016 seasons).

Treatments	Characters	Plant height (cm)	No. of tillers(m ²)	No. of spikes(m ²)	Weight of spikes(g/m ²)	Gain yield (g/m ²)	Grain index (g)
Cultivars x Bio- fertilizer							
Sohag-4	Azotobacter	127.76	477.84	473.53	780.15	527.80	45.61
	Yeast	128.91	477.17	479.08	799.19	562.15	46.36
Sakha- 94	Azotobacter	124.15	487.55	479.69	792.99	537.88	42.72
	Yeast	126.47	493.42	491.44	800.12	550.58	44.73
L.S.D. at 5%		0.10	0.46	0.26	0.44	1.34	0.09

Effect of interaction between nitrogen fertilizer (ammonia gas) and bio-fertilizer:

Data in Table (5) indicated that the highest value of plant height (cm), number of tillers/ m², number of spikes/ m², weight of spikes (g/m²), grain yield (g/m²) and grain index (g) were obtained from adding 90 kg N/feddan with Yeast inoculation.

Table 5: Effect of interaction between nitrogen fertilizer x bio-fertilizer on yield and its components of wheat plants (Average of 2014/2015 and 2015/2016 seasons).

Characters		Plant height (cm)	No. of tillers (m ²)	No. of spikes (m ²)	Weight of spikes (g/m ²)	Gain yield (g/m ²)	Grain index (g)
Treatments							
Nitrogen fertilizer(Ammonia gas) x Bio-fertilizer							
Control	Azotobacter	121.02	462.55	463.65	770.62	518.55	41.17
	Yeast	123.24	466.68	469.03	784.83	538.33	42.86
30 kg/N fed.	Azotobacter	124.26	479.52	474.05	783.64	527.54	43.40
	Yeast	126.22	480.68	483.93	795.34	551.42	44.76
60 kg/N fed.	Azotobacter	127.23	489.10	840.03	791.52	536.72	45.17
	Yeast	129.25	491.81	491.11	804.35	563.72	46.33
90 kg/N fed.	Azotobacter	131.31	499.61	488.70	800.49	548.55	46.92
	Yeast	132.05	502.03	496.93	814.11	571.94	48.22
L.S.D. at 5%		0.15	0.65	0.36	0.63	1.89	0.13

Effect of interaction between wheat cultivars x nitrogen fertilizer x bio-fertilizer:

Data in Table (6) showed that the interaction between wheat cultivars x nitrogen fertilizer x bio-fertilizer was significant in plant height (cm), number of tillers/ m², number of spikes/ m², weight of spikes (g/m²), grain yield (g/m²) and grain index (g). It is clear from Table (6) that the best value of number of tillers/ m², number of spikes/ m² and weight of spikes (g/m²) were obtained by planting Sakha-94+ 90 kg N/feddan (ammonia gas 82%)+ Yeast inoculation, while grain yield (g/m²) and grain index (g) were obtained from planting Sohag-4 cultivar with 90 kg N/feddan+ Yeast inoculation and Sohag-4 cultivar+ 90 kg N/feddan + Azotobacter for plant height.

Table 6: Effect of interaction between cultivars x nitrogen fertilizer x bio-fertilizer on yield and its components of wheat plants (Average of 2014/2015 and 2015/2016 seasons).

Characters		Plant height (cm)	No. of tillers (m ²)	No. of spikes (m ²)	Weight of spikes (g/m ²)	Gain yield (g/m ²)	Grain index (g)		
Treatments									
Cultivars x Nitrogen fertilizer(Ammonia Gas) x bio-fertilizer									
Sohag-4	Control	Azotobacter	122.57	458.60	463.66	768.59	517.25	42.76	
		Yeast	123.76	463.68	467.84	786.17	551.08	43.95	
	30 kg/N fed.	Azotobacter	125.91	475.54	470.49	774.56	522.53	44.86	
		Yeast	127.48	471.47	476.44	794.51	558.84	46.05	
	60 kg/N fed.	Azotobacter	128.88	483.69	476.50	783.54	529.77	46.65	
		Yeast	130.96	480.05	483.70	804.68	566.68	46.68	
	90 kg/N fed.	Azotobacter	133.67	493.51	483.46	793.90	541.63	48.15	
		Yeast	133.42	493.50	488.64	811.42	572.01	48.76	
	Sakha-94	Control	Azotobacter	119.48	466.49	463.65	772.65	519.85	39.58
			Yeast	122.72	469.67	470.51	783.50	525.57	41.77
30 kg/N fed.		Azotobacter	122.60	483.50	477.62	792.73	532.54	41.94	
		Yeast	124.97	489.88	491.52	796.17	543.99	43.48	
60 kg/N fed.		Azotobacter	125.59	494.50	483.56	799.49	543.67	43.68	
		Yeast	127.53	503.58	498.52	804.02	560.88	45.99	
90 kg/N fed.		Azotobacter	128.95	505.71	493.93	807.09	555.17	45.68	
		Yeast	130.67	510.56	505.22	816.80	571.86	47.69	
L.S.D. at 5%		0.21	0.92	0.52	0.89	2.67	0.19		

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