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Response of Some Wheat Varieties to Bio and Mineral Nitrogen Fertilizers

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ABSTRACT

In order to study the effect of Microbin inoculation, different rates of nitrogen fertilizer (45, 90, 135 and 180 kg ha^{-1}) and their interaction on yield and yield components and protein percentage of two wheat varieties (Sakha 93 and Gemmeiza 9) during the two successive growing winter seasons 2010/2011 and 2011/2012 seasons. The experimental design was split B split plot design with three replications, Microbin inoculations were located in main plots and four N rates fertilizers were allocated in the sup-plots and two wheat cultivars were allocated in the sub-sub plots. The highest yield was produced due to application of microbin, also the same trend was obtained with N rate of 180 kg ha^{-1}. Gemmeiza 9 recorded the highest yield compared with Sakha 93. The interaction between bio-fertilizer and N rates proved to be significant for all studied traits. The highest grain yield/ha was found with the interaction between Microbin×Gemmeiza 9. Also, the interaction between 180 kg N ha^{-1}×Gemmeiza 9 recorded the highest grain yield ha^{-1}. According to these results, rate of 180 kg N ha^{-1} and application of microbin as bio-fertilizer using variety Gemmeiza 9 could be recommended for favorable wheat production under the local environmental conditions of this study.

Key words: Wheat, microbin, nitrogen fertilizer, interaction

INTRODUCTION

Wheat is the major winter cereal grain crop and the third major crop in terms of area planted. Recently, a great attention of several investigations has been directed to increase the productivity of wheat to minimize the gap between the Egyptian production and consumption by increasing the cultivated area and wheat yield per unit area (Zaki *et al*., 2007).

Using bio-fertilizer may be supply plants with their need of nitrogen during their growth by cheap means which in turn led to significant decrease in crop production costs. In addition pollution rates in soil, water and air may be reduction as a result of this practice. Emara (1994), Sushila and Gajendra (2000) and El-Kalla *et al*. (2002) indicated that, Bio-fertilizers increased yield and yield components. Caballero *et al*. (1992) found that inoculation of wheat with various strains of *Azospirillum* significantly increased grain yield from 23-63% in 1986 and from 29-43% in 1987.

Yield and yield components increased by increasing nitrogen rates, they have also been reported by Sharshar *et al*. (2000), Sushila and Gajendra (2000) and Saleh (2002). Sharief *et al*. (1998), Atta and Swelam (2006) and Kandil *et al*. (2011) increased nitrogen rates up to N level of

178.5 kg ha^{-1} recorded the highest yield. The interaction between bio fertilizer and nitrogen levels had significant effect on yield and yield components (Ali *et al.*, 2002). Kandil *et al.* (2011) found that, the highest spike number/m^2, grain weight/spike, 1000 grain weight, biological yield, straw yield, both N and protein contents of grain were recorded with the interaction between bio-fertilizers and N levels.

Differences among the two bread wheat cultivars (Gammeiza 9 and Sakha 93) were respecting with plant height at harvest, grain weight/spike, 1000 grain weight, number of spikes/m^2, grain yield (ardab/fad.) and straw yield (ton/fad.) they stated that, Gemmeiza 9 significantly surpassed Sakha 93 cultivars in the all studied characters, Atta and Swelam (2006). Sakha 94 recorded the highest values for all studied traits, except spike length, grain weight/spike and 1000 grains weight compared with the other varieties, Hafez *et al.* (2012).

The objectives of this study were aimed to study the effect of N bio and mineral fertilizers on wheat productivity.

MATERIALS AND METHODS

The study area: The present investigation was carried out at the Exp. Farm, Fac. of Agric., Tanta Univ., Tanta, Egypt during the two successive growing winter seasons 2010/2011 and 2011/2012 to study the effect of Microbin as bio-fertilizer and nitrogen rates on yield and its components of two wheat varieties.

The experimental design and necessary management: The experimental design was split-split plots with three replications; two Bio-fertilizer treatments; without bio-fertilizer (B_1) and with bio-fertilizer (B_2) were randomly allocated in the main plots. The sub-plots were designated to rates of nitrogen; 45, 90, 135 and 180 kg ha^{-1}. The sub-sub plots randomly occupied by two wheat varieties; Sakha 93 (V_1) and Gemmeiza 9 (V_2). The treated bio-fertilizer containing N-free living bacteria (*Azotobacter* and *Azospirillum*) and a phosphate dissolving bacteria (*Bacillus megaterium*), under the trade name of Microbin. The source of Microbin was the Unit of Biofertilizer Production, General Organization for Agriculture Equalization Fund (GOAEF), Ministry of Agriculture and Land Reclamation, Egypt, (Abou El-Naga, 1993). The grain inoculation was done before sowing directly. Nitrogen in the form of urea was added as follows: 1/5 at sowing, 2/5 at first irrigation and 2/5 at second irrigation. In the two seasons, wheat crop was planted at 15th November. The unit area of experimental plot was 12 m^2 (3×4 m). The proceeding crop was maize in the two seasons. Soil samples were taken and mechanically analyzed following the methods described by Piper (1950) and chemically analyzed according to Black (1965). The soil texture of experimental soil is clay. The chemical analyses of soil were: pH (7.6), EC (1.31 dS m^{-1}), available P (9.5 mg kg^{-1}), available K (194.2 mg kg^{-1}) and total nitrogen (0.08%).

Field sampling and data collection: At harvest one square meter was taken randomly from each sub-sub plot for the last three replications to determine yield and its components:

- Plant height (cm)
- Spike length (cm)
- No. of grains/spike
- No. of spikelets/spike
- No. of spikes/m^2

- 1000-kernel weight (g)
- Grain yield (t ha^{-1})
- Straw yield (t ha^{-1})
- Harvest index (seed yield/biological yield)
- Protein percentage

Total nitrogen of seeds was determined by the conventional micro-Kjeldahl method (Varley, 1966). Crude protein content was calculated by multiplied N value by 6.25 as reported by Pirie (1955).

Statistical analysis: Data were subjected to the proper statistical analysis as the technique of analysis of variance (ANOVA) of split-split plot design as mentioned by Gomez and Gomez (1984). Treatment means were compared using the Least Significant Difference (LSD) test as outlined by Waller and Duncan (1969). The error mean squares of split-split plot design were homogenous (Bartlett's test), the combined analysis was calculated for all the studied characters in both seasons. Computations were done using computer software.

RESULTS AND DISCUSSION

Bio-fertilizer effects: Results presented in Table 1 indicate significant effects due to Bio-fertilizer for plant height, yield and its components and protein percent, except spike length in combined analysis. Microbin as bio-fertihzer treatment was significantly increased No. of spikes/m^2 by 7.91%, plant height by 1.41%, No. of grains/spike by 3.52%, No. of spikelet's/spike by 1.37%, 1000 kernels weight 1.04%, grain yield (t ha^{-1}) by 7.89%, straw yield (t ha^{-1}) by 4.83%, harvest index by 1.82% and protein percent by 5.46% than without bio-fertilizer treatment, as shown as in Table 1. Similar results found by Basha (2004). El-Moursy (1998) and Ali *et al.* (2002) found that, cerealin inoculation gave the highest grain nitrogen percentage and crude protein percentage, as well. It seems that increasing nitrogen application had favorable effect on grain quality since it builds up the protein content of grain.

Nitrogen fertilizer rate effects: Means of plant height, yield and its components and protein percentage were significantly affected by nitrogen fertilizer rates in the combined analysis, as shown in Table 1.

Increasing nitrogen fertilizer rate up to 180 kg k ha^{-1} significantly increased plant height, yield and its components and protein percentage in the combined analysis compared with 45 kg N and the other nitrogen rates. The grain yield (t ha^{-1}) due to increasing nitrogen fertilizer rate were 9.68 for 180 kg ha^{-1}, followed by 8.82 for 135 kg N, 7.15 for 90 kg N and 5.46 t ha^{-1} for 45 kg N in the combined analysis. However, increasing nitrogen rate up to 180 kg N significantly increased protein percent in the combined analysis. Similar results were found by Shalaby *et al.* (1993), Atta and Swelam (2006) and Hafez *et al.* (2012). El-Sayed and Hammed (2007) studied the effect of nitrogen rates on agronomic quality traits in three bread wheat cultivars, Sakha 93, Sakha 94 and Giza 168, the results indicated that increasing nitrogen rate up to 238 kg N ha^{-1} resulted in significant gradual increase in plant height, number of spikes/m^2, number of kernels/spike, grain yield/fad. and crud protein. Rahimi (2012) study the effect of nitrogen rates: 0, 40, 60 and 80 kg ha^{-1} as urea and

Table 1: Means of varietal differences for wheat plant height and yield as affected by bio-fertilizer, nitrogen rates and their interaction on in the combined analysis

Treatments	Plant height (cm)	Spike length (cm)	No. of grains/spike	No. of spikelet's/spike	No. of spikes (m^{-2})	1000-kernels weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index	Total protein (%)
Bio-fertilizer (B)										
B_1	88.59	8.90	56.51	18.98	308.27	46.25	7.48	12.64	37.18	11.18
B_2	89.84	9.10	58.50	19.24	332.65	46.73	8.07	13.25	37.85	11.79
$LSD_{0.05}$	0.41	-	1.05	0.04	3.66	0.06	0.06	19.00	0.24	0.19
$LSD_{0.01}$	0.95	-	-	0.09	8.45	0.13	0.15	0.43	0.55	0.43
Nitrogen rates (kg N ha^{-1}) (N)										
N_1	84.23	8.16	50.82	17.81	250.89	44.66	5.46	9.94	35.45	9.61
N_2	87.55	8.59	55.33	18.69	300.90	46.01	7.15	12.59	36.22	10.88
N_3	90.88	9.25	59.99	19.57	344.15	46.99	8.82	14.34	38.08	12.06
N_4	94.21	10.00	63.87	20.36	385.91	48.30	9.68	14.91	39.37	13.40
$LSD_{0.05}$	0.42	0.20	0.75	0.03	2.62	0.44	0.09	0.10	0.23	0.24
$LSD_{0.01}$	0.59	0.28	1.05	0.04	3.68	0.61	0.12	0.14	0.33	0.33
Varieties (V)										
V_1	90.48	9.21	54.50	18.88	304.02	46.66	7.63	12.86	37.24	11.40
V_2	87.96	8.78	60.51	19.34	336.90	46.32	7.92	13.04	37.79	11.58
$LSD_{0.05}$	0.17	0.23	0.27	0.16	2.77	0.18	0.04	0.07	0.16	0.17
$LSD_{0.01}$	0.23	0.32	0.38	0.23	3.81	0.25	0.06	0.10	0.21	-
Interactions B×N										
$B_1 \times N_1$	83.58	8.13	49.88	17.68	237.17	44.57	5.26	9.60	35.40	9.41
$B_1 \times N_2$	86.91	8.40	53.98	18.58	289.81	45.77	6.68	12.07	35.63	10.52
$B_1 \times N_3$	90.11	9.11	59.06	19.34	332.31	46.72	8.49	14.04	37.68	11.63
$B_1 \times N_4$	93.78	9.94	63.11	20.30	373.79	47.95	9.50	14.83	39.05	13.13
$B_2 \times N_1$	84.89	8.19	51.75	17.94	264.60	44.75	5.66	10.27	35.53	9.80
$B_2 \times N_2$	88.19	8.78	56.67	18.79	311.98	46.25	7.62	13.10	36.78	11.23
$B_2 \times N_3$	91.65	9.39	60.93	19.80	355.99	47.26	9.14	14.64	38.44	12.49
$B_2 \times N_4$	94.64	10.05	64.64	20.42	398.03	48.66	9.85	14.98	39.67	13.66
$LSD_{0.05}$	0.60	0.28	1.06	0.04	3.71	0.62	0.13	0.34	0.33	0.34
$LSD_{0.01}$	0.84	0.39	1.49	0.06	5.20	0.86	0.18	0.46	0.46	0.47

showed that effect of nitrogen on grain yield was highly significant. The grain yield was increased to 4800 kg ha^{-1} by the application of 80 kg ha^{-1} nitrogen. Gul *et al.* (2012) found that, higher grain yield (2994.78 kg ha^{-1}) at 130 kg N ha^{-1}. On the other hand, the lowest values of all the studied traits were recorded from the treatment of 45 kg N ha^{-1}.

Varietal differences: Results in Table 1 show that, there are significant differences in the ten traits studied in the combined analysis.

From the same Table 1, it can be noticed also that, the plants of Gemmeiza 9 variety produced the greatest values of all studied traits, except plant height, spike length and 1000 kernels weight in the combined analysis. The results clearly showed that, the highest grain yield (t ha^{-1}) found with Gemmeiza 9 in the combined analysis. The findings are in agreement with Zeidan *et al.* (2005) pointed that, Gemmeiza 3 produced the highest grain yield compared to Sakha 69 and Sakha 8.

El-Gizawy (2005) tested wheat cultivars Gemmeiza 5, 7 and Gemmeiza 9 showed significant variation for all studied traits. Gemmeiza 9 surpassed the other two cultivars in plant height, number of spikes/m^2, number of grains/spike, 1000-kernel weight and grain yield.

Interaction effects: Wheat plant inoculated with microbin×180 kg N ha^{-1} significantly produced the highest values of all studied traits in the combined analysis. Interaction Bio-fertilizer×nitrogen at 180 kg ha^{-1} were increased grain yield (t ha^{-1}) by 3.68% and protein percentage by 4.04% compared with the same dose without Bio-fertilizer Table 1. Similar results were reported by Omar *et al.* (1996) who found that, the combination of microbin inoculation and highest dose of nitrogen fertilizer of 214.2 kg N ha^{-1} gave the highest means of both grain nitrogen percentage and crude protein content in the three seasons. Bedaiwi *et al.* (1997) showed that, bio-fertilization could increase grain yield as much as 116-128% over the control by using no more than 70 or 80 kg N fad^{-1}. which accounted for 60% of the recommended mineral nitrogen (120 kg N fad^{-1}.). Kotb (1998) reported that, Sakha 69 variety showed increases of number of spikes/m^2, number of grains/spike, straw yield fad^{-1}. with increasing nitrogen fertilization level up to 75 kg N fad^{-1}. or with inoculation.

Results in Table 2 showed that, the interaction between Sakha 93 and Microbin were recorded the highest values of plant height, spike length and 1000-kernels weight while the highest values of the other traits where found with Gemmeiza 9 and Microbin. Zaki *et al.* (2012) found that, the highest values of plant height, number of grains/spike and number of spikelets/spike were obtained from planting Gemmeiza 7 cultivar with all biofertilizers inoculation Azos., yeast and (Azos.+yeast) in both seasons and 1000 grain weight only in the second season.

The interaction between nitrogen rates and wheat varieties recorded the highly significant values for all studied traits in the combined analysis, as shown as in Table 2. Increasing Nitrogen rates up to 180 kg ha^{-1} significantly increased all studied traits with variety Gemmeiza 9, except plant height and 1000 kernels weight which were found with the same rate of nitrogen and variety Sakha 93, as shown as in Table 2. Results were in accordance with those obtained by Hassanein (2001), who reported that there was a significant interaction between wheat cultivars and nitrogen levels for yield and yield components i.e., plant height, number of tillers/plant, number of spikes/plant, grain yield/plant, straw yield/plant, biological yield/plant, grain yield/fed, straw yield/fed and biological yield/fed.

Table 2: Effect of bio-fertilizer (B)×wheat varieties (V) and nitrogen rates (N)×wheat varieties (V) interaction on plant height and yield and yield components in the combined analysis

Treatments	Plant height (cm)	Spike length (cm)	No. of grains/spike	No. of spikelet's/spike	No. of spikes (m^2)
Interactions B×V					
B1×V1	89.93	9.16	53.50	18.77	293.73
B1×V2	87.26	8.63	59.52	19.19	322.81
B2×V1	91.03	9.27	55.50	18.98	314.32
B2×V2	88.66	8.93	61.49	19.50	350.98
$LSD_{0.05}$	0.24	0.33	0.39	0.23	3.92
$LSD_{0.01}$	0.32	0.45	0.53	0.32	5.39
Interactions N×V					
N1×V1	85.19	8.44	46.95	17.92	242.13
N1×V2	83.27	7.88	54.68	17.71	259.65
N2×V1	88.68	8.99	51.91	18.51	286.64
N2×V2	86.42	8.19	58.74	18.87	315.16
N3×V1	92.67	9.47	57.39	19.33	324.80
N3×V2	89.08	9.03	62.60	19.82	363.50
N4×V1	95.36	9.96	61.73	19.75	362.53
N4×V2	93.06	10.03	66.01	20.98	409.29
$LSD_{0.05}$	0.33	0.46	0.55	0.33	5.54
$LSD_{0.01}$	0.46	0.64	0.75	0.45	7.63

Treatments	1000-kernels weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index	Total protein (%)
Interactions B×V					
B1×V1	46.44	7.37	12.58	36.94	11.03
B1×V2	46.07	7.6	12.7	37.44	11.32
B2×V1	46.88	7.9	13.13	37.57	11.76
B2×V2	46.58	8.24	13.37	38.13	11.83
$LSD_{0.05}$	0.26	0.06	0.1	0.22	0.24
$LSD_{0.01}$	0.35	0.08	0.12	0.3	0.34
Interactions N×V					
N1×V1	44.32	5.31	9.7	35.38	9.54
N1×V2	45	5.61	10.18	35.53	9.68
N2×V1	46.08	7.17	12.77	35.96	10.84
N2×V2	45.94	7.14	12.43	36.48	10.92
N3×V1	47.33	8.63	14.09	37.98	11.99
N3×V2	46.65	9	14.59	38.15	12.13
N4×V1	48.9	9.43	14.88	38.79	13.22
N4×V2	47.71	9.93	14.95	39.91	13.57
$LSD_{0.05}$	0.36	0.08	0.12	0.31	0.34
$LSD_{0.01}$	0.5	0.11	0.19	0.43	0.47

Interaction of Microbin×180 kg N ha^{-1}×Gemmeiza 9 gave the highest values for all studied traits in the combined analysis, except plant height, 1000 kernels weight and straw yield which found with the same interactions but with the variety Sakha 93, as shown as in Table 3. Zaki *et al*. (2012) reported that, the effective treatments for plant height, weight of grains/spike, 1000 grains weight, straw yield and biological yield/fed. were obtained from Gemmeiza-7 cultivar with Azos+yeast+50% NPK, as well as for No. of grains/spike, spike length and grains yield/fed. was Sakha-93 with Azos+yeast+50% NPK.

Table 3: Bio-fertilizer (B)×nitrogen rates (N)×wheat varieties (V) interaction effect on plant height and yield and yield components in the combined analysis

Treatments	Plant height (cm)	Spike length (cm)	No. of grains/spike	No. of spikelet's/spike	No. of spikes (m^2)
B1×N1×V1	84.58	8.37	46.28	17.83	229.75
B1×N1×V2	82.58	7.88	53.48	17.53	244.58
B1×N2×V1	88.01	8.82	50.32	18.43	277.17
B1×N2×V2	85.80	7.98	57.65	18.73	302.46
B1×N3×V1	92.02	9.44	56.05	19.12	315.13
B1×N3×V2	88.20	8.77	62.07	19.57	349.50
B1×N4×V1	95.10	10.01	61.33	19.70	352.88
B1×N4×V2	92.47	9.87	64.88	20.91	394.71
B2×N1×V1	85.81	8.50	47.63	18.00	254.50
B2×N1×V2	83.97	7.87	55.88	17.88	274.71
B2×N2×V1	89.36	9.16	53.50	18.58	296.10
B2×N2×V2	87.03	8.40	59.83	19.00	327.85
B2×N3×V1	93.33	9.50	58.73	19.53	334.48
B2×N3×V2	89.97	9.28	63.13	20.07	377.50
B2×N4×V1	95.62	9.91	62.13	19.80	372.19
B2×N4×V2	93.66	10.19	67.14	21.04	423.88
$LSD_{0.05}$	0.47	0.66	0.77	0.46	7.83
$LSD_{0.01}$	0.65	0.91	1.06	0.64	10.79
Treatments	1000-kernels weight (g)	Grain yield (t ha^{-1})	Straw yield (t $ha^{-}11$)	Harvest index	Total protein (%)
B1×N1×V1	44.17	5.12	9.38	35.31	9.22
B1×N1×V2	44.97	5.40	9.82	35.48	9.60
B1×N2×V1	45.87	6.80	12.43	35.36	10.36
B1×N2×V2	45.67	6.56	11.74	35.85	10.68
B1×N3×V1	47.19	8.31	13.82	37.55	11.56
B1×N3×V2	46.25	8.67	14.26	37.81	11.71
B1×N4×V1	48.52	9.24	14.69	38.61	12.98
B1×N4×V2	47.38	9.76	15.00	39.42	13.28
B2×N1×V1	44.47	5.50	10.01	35.46	9.85
B2×N1×V2	45.04	5.82	10.54	35.57	9.76
B2×N2×V1	46.29	7.53	13.10	36.50	11.31
B2×N2×V2	46.21	7.72	13.10	37.08	11.15
B2×N3×V1	47.47	8.95	14.35	38.41	12.42
B2×N3×V2	47.04	9.34	14.93	38.48	12.56
B2×N4×V1	49.27	9.62	15.05	38.99	13.45
B2×N4×V2	48.04	10.09	14.93	40.33	13.86
$LSD_{0.05}$	0.51	0.12	0.19	0.44	0.49
$LSD_{0.01}$	0.71	0.16	0.26	0.61	0.67

Generally, it can be concluded that for the two cultivars the lowest values were obtained by uninoculation. These results are in harmony with those obtained by Hassanein and Gomaa (2001), Hosam El-Din (2007) and Shoman *et al.* (2006).

CONCLUSION

From the present results under the same conditions we can recommended that, the interaction between bio-fertilizer, Gemmeiza 9 and 180 kg N ha^{-1} obtained that highest grain yield ha^{-1}.

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