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SYNERGISTIC EFFECT OF NITROGEN FIXERS AND NITROGEN FERTILIZER ON WHEAT IN SANDY SOIL

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ABSTRACT

Two field experiments were conducted in sandy soil at El-Bustan region, El Behera Governorate during two winter successive seasons of 2004/2005 and 2005/2006 to evaluate the effect of five nitrogen fertilizer levels (71.5, 143, 214, 286, and 357 kg/ha) represented (25, 50, 75, 100 and 125% of the recommended dose) and some isolates of nitrogen fixing bacteria (*Azospirillum* sp,, *Azotobacter* sp, *Bacillus* sp. and *Klebsiella* sp.) on growth and yield of six bread wheat lines. Results showed that the interaction between genotypes and nitrogen levels was significantly positive for wheat yield and its components, while the harvest index was not significant. However, the highest grain yield was obtained from the biofertilized lines numbers 15, 11 and 21 at 214 kg N/ha, lines number 8 and 21 at 286 Kg N/ha and lines 8 and 15 receiving 143 Kg N/ha. Moreover, they surpassed the grain yield of the control treatment (286 kg N/ha) by 0.80, 0.87, 0.55, 0.72, 0.59, 0.52 and 0.30 ton/ha (14, 16, 10, 13, 11, 10 and 5%) respectively. In addition, these seven combinations exceeded the commercial cultivar Sids 1 under control treatment by 1.46, 1.23, 1.04, 1.16, 1.08, 0.96 and 0.95 ton/ha (29, 24, 21, 23, 21 19 and 19%), respectively. Results also, indicated that lines: 8 and 15 expressed high stability level in grain yield due to both tested seasons. They also, outyielded the commercial check Sids 1, under biofertilization with no more than 143 kg N/ha, saving 50% of the mineral nitrogen recommended dose. Such lines should save money and environmental health. Therefore, both lines are highly recommended for yield tests in the advanced yield trails, which are conducted all over the country.

Keywords: Wheat, nitrogen fixers, *Azospirillum* sp., *Azotobacter* sp., *Bacillus* sp., *Klebsiella* sp. sandy soil.

INTRODUCTION

In Egypt, raising wheat production through increasing the productivity of unit area together with expanding the cultivated area in newly reclaimed soil is the most important national target. Increasing the productivity of unit area can be achieved by cultivating high yielding cultivars in parallel with improving agronomic practices. The extensive application of nitrogen fertilization in both old and new lands have raised serious environmental concerns due to the possibility of contaminating potable water sources, and subsequently creating health hazardous to both human being and living stocks as well. On the other hand, irrational utilization of chemical nitrogen fertilizers has been a serious problem due to the increase of production costs. . Therefore, development of new cultivars responsive to low level of fertilization and simultaneously yield sustainable are much needed. This led to considerable interest in biological N_2-fixation as an eco-friendly approach to minimize the use of chemical fertilizers, improve soil fertility status and for enhancement of crop production by their biological activities in the rhizosphere.

Many reports indicated that inoculation of seed wheat plants with associative N_2-fixing bacteria led to changes in plant growth and yield. Lippmann *et al.* (1995) reported that application of a composite of N_2 fixers (*Azospirillum* spp., *Azotobacter* spp. and *Bacillus* spp.) cause significant increases in plant dry weight, N-content and yield of wheat. This might be due to the possible production of a mixture of plant growth promoting substances. Soliman *et al.* (1995) found that the inoculation with *Azotobacter chroococcum* and *Azospirillum brasiliense* either each applied singly or both in combination, under various levels of ammonium sulfate had increased straw, grain yield and N-uptake by wheat plants with increasing of nitrogen levels. The highest wheat yield was achieved by using a mixture of *Azotobacter chroococcum* and *Azospirillum brasiliense*. Swedrzynska (2000) reported that inoculation of wheat with active strain of *Azospirillum brasilense* led to increase in yield up to 27% comparing with uninoculated plants. Khan and Zaidi (2007) found that the triple inoculation with *Azotobacter chroococcum*, *Bacillus* sp. and *Glomus fasiculatum* increased significantly the dry mater and grain yield by 2.6 and 2 fold respectively above that non-inoculated wheat plants.

Under Egyptian conditions, Eid *et al.* (1986) found that grain yield of barley cv. Giza 121 and wheat cv. Giza 155 increased by 67 and 45% for both cvs., respectively, with N_2-fixing bacteria, indicating the importance of the varietal response to such biofertilizers. Bedaiwi *et al.* (1997) found that biofertilization could save 40% of nitrogen requirements for wheat in the new lands. Also, Mitkees *et al.* (1998a) found that six out of 21 bread genotypes produced the highest yields under biofertilization in addition to only half of the recommended nitrogen does (286 kg/ha). Aly (2003) stated that some of diazotrophus are capable to produce some hormones namely indol acetic acid, indol 3-butric acid, indol 3-ethanol, absicisic acid, several gibberellins, cytokinins and other organic acids, which solubilize inorganic forms of phosphorus and other elements that are unavailable to plant. Elsayed *et al.* (2005) stated that nitrogen biofertilizer (Cerealin) had a positive effect on wheat plant trails measured and on the grain yield. Reda *et al.* (2006) found that inoculation with N_2-fixers lead to increase in wheat grain yield and its nutrient contents particularly in the presence of 50% of nitrogen fertilizer recommended dose.

This work is undertaken to evaluate the response of six bread wheat lines in addition to the commercial cultivar Sids 1 to different levels of mineral nitrogen fertilizer under nitrogen biofertilization in comparison with the recommended nitrogen dose due to their yields and their components as well as their rhizosphere nitrogenase activities at 40 and 80 day from sowing.

MATERIALS AND METHODS

Two field experiments were conducted in sandy soil at El-Bustan region in El-Behera Governorate, during 2004/2005 and 2005/2006 winter growing seasons to study the effect of N_2-biofertilization on response of six promising bread wheat lines (obtained from the lines proved their superiority in primary yield trials) in addition to the commercial cultivar Sids 1 (Table 1), to five nitrogen fertilizer levels (71.5, 143, 214, 286, and 357 kg/ha) represented 25, 50, 75, 100 and 125% of the recommended level in the region (about 30, 60, 90, 120, and 150 kg N/fed), under nitrogen biofertilization (as seed coating at sowing) comparing to the recommended treatment (288 kg N/ha) without nitrogen biofertilization (control).

Table (1): List of the studied wheat genotypes and their cross names and pedigrees

Genotypes		Name and Pedigree
Sids1	Control	
L-8	Nac/Vee "S"	CM 64224-2PA-2PA-1AP-3AP-5AP-0AP
L-9	Buc(S)/FLK "S"//Maya "S"/VUL "S"	CM 91575-28Y-0M-0Y-4M-0Y
L-11	Nac/Vee "S"	CM 64224-2AP-2AP-1AP-1AP-1AP-0AP
L-15	Seri # 3/Buc "S"	CRG 68 – C-100-3B
L-20	DW 15023/Snb "S"//Snb "S"	CM 84986-H-1M-2Y-5B-0Y
L-21	Juf/BJY "S"//Ures	CM 67458-3Y-1M-3Y-1M-3Y-0B

Nitrogen fixing bacteria were isolated from the rhizosphere soil samples of wheat grown at El-Bustan experimental site. Ten isolates were purified (Bergy's manual, 1984) and the ability of these isolates to fix nitrogen was tested by determining nitrogenase activity (Hegazi *et al.,* 1979) as shown in Table (2). The highest isolates in nitrogenase activity were selected and used as a mixture (isolates No. 7 for *Azospirillum* sp., No. 9 for *Azotobacter* sp., No. 2 for *Bacillus* sp., and No. 10 for *Klebsiella* sp.) and were grown each separately on semi-solid malate medium (Doberiner, 1978), modified Ashby's medium (Abdel-Malek and Ishac, 1968), Hino and Wilson medium (Hino and Wilson, 1958) and Yoch and Pengra (Yoch and Pengra, 1966) for 7 days at 30°C, respectively. A mixed culture were prepared just before grain inoculation to reach the final density to 10^8 cells/ml. Wheat grains were successively washed before sowing in tap water and coated with the selected nitrogen fixing isolates using Arabic gum (6%) as an adhesive agent. Irrigation was practiced just after sowing.

Table (2): Nitrogenase activity (μ mole C_2H_4/ml culture/h) of *Azospirillum* sp., *Azotobacter* sp., *Bacillus* sp., and *Klebsiella* sp. isolates

Ser. No of isolates	*Azospirillum* sp.	*Azotobacter* sp.	*Bacillus* sp.	*Klebsiella* sp.
1	30.2	51.8	9.2	20.4
2	6.6	18.8	25.4	--
3	18.6	14.8	11.8	30.6
4	36.2	27.8	17.9	20.0
5	70.5	41.5	20.6	--
6	16.6	34.8	22.0	--
7	80.4	6.11	14.9	40.1
8	41.3	--	--	8.6
9	56.8	59.5	--	5.11
10	25.5	13.8	--	39.8

During land preparation, phosphorus fertilizer was applied in a rate of 72 kg P_2O_5/ha in the form of mono-ammonium phosphate. Likewise, potassium fertilizer was added in two equal split doses (57 kg K_2O/ha each) applied as potassium sulphate (48% K_2O) during land preparation and at booting stage. Nitrogen fertilizer as ammonium nitrate (33%) was applied at six rates according to the studied treatments. Nitrogen fertilizer was splitted in all cases into six equal doses applied right before irrigation starting from plant emergence to the end of booting stage. The soil of the experimental site was sandy in texture having low available nitrogen as well as phosphorus and organic matter. However, chemical and mechanical analyses are presented in Table (3).

Table (3): Some chemical and mechanical properties of the experimental soils

Analysis	Seasons	
	2004/2005	2005/2006
Chemical properties:		
EC (dSm^{-1})	0.17	0.12
PH (1: 2.5)	8.20	8.20
N (ppm)	13.00	15.00
P (ppm)	11.00	16.00
K (ppm)	60.00	65.00
$CaCO_3$%	5.50	5.80
OM%	0.50	0.45
Mechanical size distribution:		
Sand%	91.10	89.40
Silt%	1.10	1.10
Clay%	7.80	9.50
Soil texture	Sandy	Sandy

Experiments were laid out in a split plot design with four replications. The wheat genotypes were assigned to the main and fertilization levels to the sub-plots. The plot area was 4.5 m^2. The preceding crop was maize in each season. Sowing was taken place during the last week of November in both seasons at row spacing of 15 cm using 400 seeds/m^2. Fixed sprinkler irrigation system was used at 7-days intervals. Other cultural practices recommended for the region were followed. For the biological analysis, wheat rhizosphere soil samples were collected at 40 and 80 days from sowing and analyzed for nitrogenase activity according to Hegazi *et al.* (1979). The crop was harvested on May 1st for both seasons. Data were collected for grain yield, straw yield, number of spikes/m^2, number of kernels/spikes and 1000 kernel weight. Collected data were subjected to statistical analysis according to Steel and Torrie (1980). In addition, curve linear regression analysis (Steel and Torrie, 1980) was performed to illustrate the response to nitrogen levels under biofertilization condition. Applying principles of Eberhart and Russel (1966), stability study was performed over the six promising wheat lines during both tested seasons.

RESULTS AND DISCUSSION

The combined analysis over data of the two wheat growing seasons, 2004/2005 and 2005/2006 revealed that:

a) Some microbial activities in soil:

1. Nitrogenase enzyme activity:

Results in Tables (4 & 5) revealed that at the periods of 40 and 80 days from sowing, lines number 15, 8 and 21 gave the highest nitrogenase enzyme activity irrespective of fertilization treatments. Moreover, the nitrogenase activity of these three lines was greater than those recorded by the commercial cultivar Sids 1. The corresponding values were 14.2, 8.7 and 7.2 n mole C_2H_4/g dry soil/h after 40 day and 25.4, 23.2 and 20.1 n mole C_2H_4/g dry soil/h, respectively, after 80 day from sowing. Regarding nitrogen fertilizer effect, the result indicated that 214 kg N/ha gave the best nitrogenase activity (44 and 93.3 n mole C_2H_4/g dry soil/h) at both tested periods, respectively. Similarly, in the interaction between genotypes and nitrogen levels the highest nitrogenase enzyme activities due to the inoculated lines numbers 15, 8 and 21 when supplemented with 214 kg N/ha after 40 and 80 days from sowing.

Table (4): Nitrogenase enzyme activity of some new lines of bread wheat rhizosphere as affected by different nitrogen levels under N_2-biofertilization at El-bustan region combined over 2004/2005 and 2005/2006 growing seasons

	Nitrogenase activity (n mole C_2H_4/g dry soil/h)	
	40 days	**80 days**
Genotypes (g)		
Sids 1	26.5	50.3
L8	35.2	73.5
L9	27.3	55.0
L11	28.9	59.1
L15	40.7	75.7
L20	26.8	53.2
L21	33.7	70.4
LSD for G at 0.05	3.2	6.1
Fertilization (N)		
N_2-fixers + 71.5kg N/ha	33.3	73.0
N_2-fixers + 143kg N/ha	41.8	86.7
N_2-fixers + 214kg N/ha	44.0	93.3
N_2-fixers + 286kg N/ha	41.6	78.3
N_2-fixers + 357kg N/ha	34.2	70.0
Control 286 kg N/ha	24.2	35.4
LSD for N at 0.05	4.5	7.8

2. Dehydrogenase enzyme activity:

Dehydrogenase activity is commonly used as an indicator of biological activity in soil. Results in Tables (6 & 7) indicated that at the periods of 40 day from sowing, lines number 8, 21 and 15 gave the highest dehydrogenase enzyme activity (53.8, 53.4 and 50.5 µg TPF/g dry soil/h). After 80 day from sowing, lines number 21, 8 and 15 gave the highest dehydrogenase activity

(93.0, 87.6 and 86.8 µg TPF/g dry soil/h). Generally, enzyme activities of these three lines were significantly increased than those recorded by the commercial cultivar Sids 1 at both periods, irrespective of fertilization treatments.

Table (5): Nitrogenase enzyme activity as affected by the interaction between some new lines of bread wheat and nitrogen fertilization levels under N_2-biofertilization at El-Bustan region combined over 2004/2005 and 2005/2006 growing seasons

Nitrogenase enzyme activity (n mole C_2H_4/g dry soil/h)												
Treatm. / Genotypes	Kg N/ha + biofertilizer					Control	Kg N/ha + biofertilizer					Control
	71.5	143	214	286	357		71.5	143	214	286	357	
	40 days						80 days					
Sids 1	20.9	33.3	33.3	31.2	25.1	15.2	50.2	60.2	69.3	56.3	45.2	20.3
L8	29.3	39.4	43.2	44.1	33.8	21.3	67.8	81.4	91.8	80.1	78.4	38.7
L9	22.5	30.9	34.2	31.5	25.2	19.4	51.8	69.2	79.0	56.2	44.4	29.2
L11	28.5	35.2	33.2	28.2	28.1	20.2	64.2	73.6	63.2	64.2	61.8	27.4
L15	40.6	44.8	50.6	48.3	36.4	23.3	80.2	90.2	94.2	83.4	73.2	33.2
L20	24.3	32.2	31.2	27.2	26.2	19.4	53.4	69.2	74.1	52.2	48.2	22.3
L21	33.5	35.2	38.1	39.0	30.2	26.2	70.2	76.3	88.0	77.4	69.1	41.2
LSD at 0.05	5.5						8.2					

Table (6): Dehydrogenas enzyme activity of some new lines of bread wheat rhizosphere as affected by different nitrogen levels under N_2- biofertilization at El-bustan region combined over 2004/2005 and 2005/2006 growing seasons

Treatment	Dehydrogenase activity (µg TPF/g dry soil/h)	
	40 days	80 days
Genotypes (g)		
Sids 1	38.2	68.2
L8	53.5	87.6
L9	37.8	70.0
L11	42.7	78.6
L15	50.6	86.8
L20	37.8	69.6
L21	53.4	93.0
LSD for G at 0.05	5.1	7.9
Fertilization (N)		
N_2-fixers + 71.5kg N/ha	30.8	59.9
N_2-fixers + 143kg N/ha	39.6	71.4
N_2-fixers + 214kg N/ha	48.3	82.1
N_2-fixers + 286kg N/ha	56.3	94.5
N_2-fixers + 357kg N/ha	57.4	95.7
Control 286 kg N/ha	38.1	71.3
LSD for N at 0.05	4.4	9.2

Regarding nitrogen fertilizer effect, the result showed that the highest activity was achieved due to the soil supplemented with 357 and 286 kg N/ha (57.4 and 56.3 µg TPF/g dry soil/h) and (95.7 and 94.5 µg TPF/g dry soil/h) at both periods, respectively. Owing to the interaction between genotypes and nitrogen levels the highest dehydrogenase enzyme activities were observed in inoculated lines numbers 8, 21 and 15 at any levels of nitrogen fertilizer and the highest activity for these lines were found when the soil was supplemented with 286 kg N/ha. after 40 and 80 days from sowing.

Table (7): Dehydrogenas enzyme activity as affected by the interaction between some new lines of bread wheat and nitrogen fertilization levels under N_2-biofertilization at El-Bustan region combined over 2004/2005 and 2005/2006 growing seasons

Dehydrogenas enzyme activity (µg TPF/g dry soil/h)												
Treatm.	Kg N/ha + biofertilizer					Control	Kg N/ha + biofertilizer					Control
	71.5	143	214	286	357		71.5	143	214	286	357	
Genotypes	40 days						80 days					
Sids 1	23.4	33.0	42.1	49.2	50.2	31.4	51.2	60.9	69.3	83.4	84.2	60.2
L8	40.3	48.3	58.1	67.2	63.4	45.2	69.4	80.2	92.3	107.3	104.2	72.3
L9	24.5	33.2	42.2	49.5	51.2	34.2	53.2	64.2	74.2	82.3	84.1	62.0
L11	28.5	38.1	45.2	53.2	55.2	35.2	58.1	69.3	81.3	94.8	98.2	69.8
L15	36.4	44.2	52.3	61.3	65.4	44.2	66.0	82.3	91.3	102.3	104.8	74.3
L20	24.2	32.3	41.3	49.1	50.1	30.2	53.1	64.0	73.2	82.4	87.3	59.4
L21	38.2	47.9	57.2	64.3	66.2	46.3	68.1	79.2	92.8	109.3	107.3	101.2
LSD at 0.05	6.8						10.2					

b) Grain yields and other agronomic traits

There were significant differences in grain yield number of spikes/m^2, 1000-kernel weight and harvest index (HI) due to the genotypes effect. Lines number 15, 8, 21 and 11 were statistically at par and gave the highest grain yields irrespective of fertilization treatments. Moreover, these four lines outyielded the commercial cultivar, Sids 1 by 0.66, 0.53, 0.47 and 0.46 ton/ha (13, 10, 9 and 9%), respectively. These increments generally could be due to more spikes/m^2, large numbers of kernels/spike and heavy kernel weight as compared to the other genotypes. Meanwhile, differences in number of kernels/spike were not significant in that respect (Table 8). On the other hand, no significant difference in straw yield character had been detected among the studied genotypes. These results are in agreement with those obtained by Mitkees *et al.* (1989), Sadek *et al.* (1995), Abo Warda (1997), Hanna *et al.* (1997) and Sadek and Abo Warda (1998).

Regarding nitrogen fertilizer effect, the results indicated that 214 kg N/ha (75% of the recommended dose) in presence of biofertilization, was sufficient to achieve the highest grain yield and saved 71 kg N/ha. Furthermore, these treatments exceeded the control treatment (286 kg N/ha without biofertilization) by 0.52 ton/ha (10%). This might be attributed to corresponding increases in number of the productive tillers expressed as number of fertile spikes/ m^2, number of kernels/spike and 1000-kernel weight. On the other hand, adding more nitrogen than 214 kg N/ha decreased the grain yield. In spite of the progressive increase in straw yield with increasing nitrogen supply in all plots treated with nitrogen biofertilization, the harvest index significantly decrease with more than 214 N/ha. This indicates that adding nitrogen more than 75% of the recommended dose stimulated the initiation of the nonproductive tillers.

These results are in agreement with those obtained by Mitkees *et al.* (1996), Bedaiwi *et al.* (1997) and Mitkees *et al.* (1998a).

Table (8): Wheat grain yield and other agronomic traits of some new lines of bread wheat as affected by different nitrogen levels under N_2-biofertilizer at El-bustan region combined over 2004/2005 and 2005/2006 growing seasons

	Grain yield ton/ha	Straw yield ton/ha	Harvest index (%)*	Number of spikes/ m^2	Number of kernels/ spike	1000-kernal weight (g)
Genotypes (g)						
Sids 1	5.14	12.0	30.2	429	40.5	41.3
L8	5.67	12.6	31.2	447	42.1	43.2
L9	5.50	12.4	30.8	427	41.5	43.6
L11	5.60	12.5	31.2	428	42.4	44.1
L15	5.80	12.4	32.0	445	42.1	43.3
L20	5.45	12.1	31.0	437	41.6	43.0
L21	5.61	11.9	32.2	456	42.1	42.5
LSD for G at 0.05	0.29	NS	1.1	21.0	NS	1.1
Fertilization (N)						
N_2-fixers + 71.5kg N/ha	4.85	10.4	32.0	383	39.3	41.3
N_2-fixers + 143kg N/ha	5.71	12.0	32.2	454	42.3	43.0
N_2-fixers + 214kg N/ha	5.92	12.4	32.4	458	43.6	44.1
N_2-fixers + 286kg N/ha	5.67	13.5	29.5	446	42.4	43.4
N_2-fixers + 357kg N/ha	5.69	13.7	29.3	456	41.8	43.6
Control 286 kg N/ha	5.40	11.5	32.0	434	41.0	42.7
LSD for N at 0.05	0.18	0.4	0.8	14	1.1	1.4
G × N interaction	*	*	NS	*	*	*

* Harvest index (HI) = Grain yield /. Grain yield + Straw yield.

Similarly, the interaction between genotypes and nitrogen levels was in a positive significant trend for the yield and its components, while, the harvest index was not significant (Table 9). However, the highest grain yield was obtained from the biofertilized lines number 15, 11 and 21 at 214, lines number 8 and 21 at 286 and lines 8 and 15 receiving 143 kg N/ha. Moreover, they surpassed the grain yield of the control treatment by 0.80, 0.87, 0.55, 0.72, 0.59, 0.52 and 0.30 ton/ha (14, 16, 10, 13, 11, 10 and 5%), respectively. In addition, these seven combinations exceeded the commercial cultivar Sids 1 under control treatment by 1.46, 1.23, 1.04, 1.16, 1.08, 0.96 and 0.96 ton/ha (29, 24, 21, 23, 21, 19 and 19%), respectively. Therefore, wheat lines number 15, 11 and 21 at 214 kg or lines 15 and 8 even at 134 kg N/ha treated with N_2-fixers, had saved 71-144 kg N/ha. These increments in grain yield could be attributed to their high values for all yield components (Table 7). The obtained results are in harmony with those reported by Mitkees *et al.* (1996) Bedaiwi *et al.* (1997), Mitkees *et al.* (1998a and b) and Massoud (2005).

Table (9): Wheat grain yield and other agronomic traits as affected by the interaction between some new lines of bread wheat and nitrogen fertilization levels under N_2-biofertilizer at El-Bustan region combined over 2004/2005 and 2005/2006 growing seasons

Genotypes (g)	Kg N/ha + biofertilizer					Control	Kg N/ha + biofertilizer					Control
	71.5	143	214	286	357		71.5	143	214	286	357	
	Grain yield (ton/ha)						Straw yield (ton/ha)					
Sids 1	4.34	5.39	5.43	5.12	5.51	5.03	9.4	11.5	12.2	12.8	13.9	11.9
L8	4.76	5.99	5.68	6.19	5.93	5.47	10.8	12.3	12.6	14.4	13.9	11.5
L9	4.76	5.58	5.78	5.47	5.93	5.46	10.9	11.8	12.2	13.6	13.8	12.2
L11	5.01	5.93	6.26	5.09	5.94	5.39	10.1	12.7	13.1	13.0	14.3	11.6
L15	4.80	5.99	6.49	5.88	5.97	5.89	10.2	12.7	13.0	13.4	14.6	10.7
L20	5.08	5.43	5.59	5.80	5.47	5.25	10.5	11.5	12.1	13.3	13.4	12.0
L21	5.19	5.68	6.07	6.11	5.08	5.52	10.7	11.6	11.5	14.1	11.9	11.4
CV%	9						9					
LSD at 0.05	0.52						1.1					
	Harvest index (%)						Number of spike/m^2					
Sids 1	31.2	31.8	30.9	28.8	28.4	30.0	372	452	428	438	453	433
L8	30.8	32.6	31.1	30.2	29.9	32.4	358	485	454	471	479	436
L9	30.9	32.1	32.1	28.6	29.9	31.3	366	439	441	432	450	424
L11	33.2	31.7	32.3	28.5	29.5	31.8	398	446	459	392	462	414
L15	32.3	32.0	33.4	30.6	28.8	34.8	367	465	495	452	457	434
L20	32.7	32.1	32.0	30.2	28.7	30.6	400	431	436	455	455	443
L21	32.7	32.8	34.7	30.1	20.2	32.8	421	457	491	485	425	455
CV%	8						9					
LSD at 0.05	N S						37					
	Number of kernels/spike						1000-kernel weight (gm)					
Sids 1	38.0	40.5	42.9	41.3	39.1	41.1	39.6	41.1	43.1	41.3	41.8	40.8
L8	39.9	42.9	44.6	44.4	40.8	39.9	39.6	44.0	43.0	44.5	44.5	43.4
L9	38.1	42.3	42.5	41.0	42.8	42.3	42.5	43.1	44.8	42.1	45.4	43.8
L11	39.1	43.9	43.8	41.8	44.3	41.6	43.0	44.8	46.1	42.6	45.8	42.5
L15	38.6	43.1	43.3	44.6	43.3	39.6	41.6	43.5	44.6	44.0	43.8	42.1
L20	40.3	40.8	43.9	41.1	42.1	41.3	42.4	42.5	44.0	44.2	42.0	43.0
L21	41.4	43.0	44.3	42.4	40.4	41.1	40.0	41.8	42.9	45.4	41.8	43.3
CV%	7.2						6.0					
LSD at 0.05	3.0						1.8					

Regression analysis for the averaged values over both tested seasons showed that lines number 8, 15, 20 and 21 had the highest coefficients of determination (78.7, 82.7, 96.0 and 88.7%) as compared with 68% for Sids 1 (Table 10 and Fig. 1). Lines number 8, 15 and 21 yielded the maximum, i. e., 6.12, 6.37 and 6.10 t/ha at 274, 247 and 218 kg N/ha (115, 104 and 90 kg N/fed), respectively, outyielding the commercial check Sids 1 by 0.63, 0.88 and 0.61 t/ha (11, 16 and 11%) respectively, at 276 kg N/ha (116 kg N/fed). However, decreasing nitrogen application to 143 kg N/ha would insignificantly decrease the yield with no more than 0.25-0.50 t/ha (4-8%). These results are supported by those obtained by Mitkees *et al.* (1998a) and Bedaiwi *et al.* (1997).

Table (10): Regression analysis of response of some new promising bread wheat lines to nitrogen fertilization under N_2-biofertilizer

Genotypes (g)	Regression parameters			R%	S-y	P<	Maximum N		143 kg
	a	b	c				Kg N/ha	t \ha	N/ha t/ha
Sids 1	3.697	0.0130	$-235E^{-7}$	68.1	0.38	0.32	276	5.49	5.09
L 8	3.855	0.0165	$-320E^{-7}$	78.7	0.37	0.21	274	6.12	5.60
L 9	4.205	0.0106	$-174E^{-7}$	74.2	0.33	0.28	305	5.82	5.37
L 11	4.510	0.0114	$-231E^{-7}$	23.4	0.70	0.77	246	5.90	5.66
L 15	3.439	0.0237	$-780E^{-7}$	82.7	0.37	0.17	247	6.37	5.85
L 20	4.385	0.0107	$-212E^{-7}$	96.0	0.08	0.04	252	5.74	5.48
L 21	3.857	0.0206	$-474E^{-7}$	88.7	0.23	0.11	218	6.10	5.84

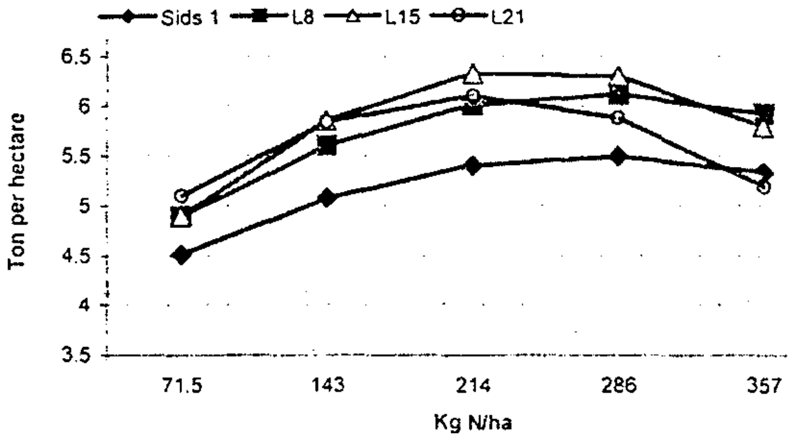

Fig. (1): Response of bread wheat lines to nitrogen fertilizer under N_2-biofertilization.

Stability study shown in Table (11) confirmed the pooled results for the two lines 8 and 15. They possessed the highest coefficients of determination (CD%) being 86 and 78%, respectively. The regression slope (b) for both lines did not significantly differ from unity (1.122 and 1.159) indicating their fitness for moderate environment and may respond for better ones. Also, divation from regressions approached zero showing their good stability over the 12 treatments (environments).

Table (11): Stability parameters for the seven studied wheat genotypes over twelve treatments

Genotypes	Means ± SE	Slope B $\pm S_b$	S^2d	CD%
Sids 1	5.14 ± 0.57	0.943 ± 0.166	0.8528	76
L8	5.67 ± 0.66	1.122 ± 0.168	0.9530	86
L9	5.50 ± 0.66	1.160 ± 0.136	0.6668	86
L11	5.60 ± 0.61	0.767 ± 0.270	2.3959	44
L15	5.80 ± 0.71	1.210 ± 0.194	1.2658	78
L20	5.54 ± 0.74	1.159 ± 0.241	1.9945	68
L21	5.61 ± 0.61	0.642 ± 0.299	2.9772	31

In conclusion, both lines of 8 and 15 are highly responsive to nitrogen biofertilizer under low levels (no more than 143 kg N/ha "50% of recommended dose") of chemical nitrogen fertilizer. So, the exploitation of such genetic variability should be the best goals to maximize the wheat productivity under low inputs in sandy soil, saving money and environmental health. Therefore, these two lines are highly recommended for yield tests in the advanced yield trails conducted allover the country.

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التأثير التعاوني للتسميد النيتروجينى والتسميد الحيوى على محصول القمـح فـى الأرض الرملية

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أجريت تجربيتان حقليتان فى أرض رملية بمنطقة البستان بمحافظـة البحيـرة خـلال موسمين شتويين متعاقبين (٢٠٠٤ /٢٠٠٥ ، ٢٠٠٥/٢٠٠٦) لتقييم إستخدام خمس مستويات مـن التسميد النيتروجينى المعدنى (٧١،٥، ١٤٣، ٢١٤، ٢٨٦، ٣٥٧ كجم نيتروجين / هكتار)والتـى تمثل (٢٥ ،٥٠، ٧٥، ١٠٠،١٢٥% من جرعة التسميد النيتروجينى الموصى بها) مع عـزلات من البكتريا المثبتة لنيتروجين الهـواء الجـوى *Azotobacter* sp.*Azospirillum* sp ,. , *Bacillus* sp and *Klebsiella* sp. على نمو و محصول ست سلالات من قمـح الخبـز ، وكانت اهم النتائج المتحصل عليها أن التفاعل بين السلالات ومعاملات التـسميد كانـت معنويـة للمحصول ومكوناته ، وقد تحقق أعلى محصول للحبوب عنـد المعاملـة بمثبتـات النيتـروجين والسلالات أرقام ١٥ ،١١ ،٢١ عند مستوى ٢١٤ كجم نيتروجين / هكتار ، والسلالات أرقام ٨ ، ٢١ عند مستوى ٢٨٦ كجم نيتروجين / هكتار ،والسلالات رقم ٨ ،١٥ عند مسـتوى ١٤٣ كجـم نيتروجين /هكتار ،. أيضاً تفوق محصول هذة المعاملات نفسها على معاملة الكنترول (٢٨٦ كجم نيتروجين / هكتار بدون تلقيح بكتيرى) بمقدار ٠,٨٠ ،٠,٨٧ ، ٠,٥٥ ، ٠,٧٢ ،٠,٥٩ ، ٠,٥٢ و ٠,٣٠ طن / هكتار (١٤ ،١٦ ،١٠ ،١٣ ،١١ ،١٠ ،و ٥ %) على الترتيب . هذا بالإضافة إلـى أن السبع معاملات قد تفوقت أيضاً على الصنف التجارى سدس ١ تحت معاملة الكنترول بمقـدار ١,٤٦ ،١,٢٣ ،١,٠٤ ،١,١٦ ، ١,٠٨ ،٠,٩٦ ، ٠,٩٦ طن / هكتـار (29، ٢٤ ،٢١ ،٢٣ ،٢١ ،١٩ و١٩%) على الترتيب ، وقد اظهرت النتائج كذلك ان الـسلالتين أرقـام ٨ ،١٥ تتميـزان بمستوى عال م الثبات الوراثى خلال السنتين مع كل من المعاملات تحت الدراسة . أيضاً تفوقـت هاتان السلالتان على الصنف التجارى سدس ١ تحت ظروف التسميد الحيوى مع ٥٠% فقط مـن التسميد النيتروجينى الموصى به ، مثل هذة السلالات من شأنها أن تقلل تكاليف الانتاج وكذا تقلـل من التلوث البيئى ، لذا يوصى باختيار هاتان السلالاتين فى تجارب أخرى على مستوى الجمهورية