

RESPONSE OF WHEAT PLANTS TO SOME BIOFERTILIZATION TECHNIQUES IN NEWLY RECLAIMED SANDY SOIL

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ABSTRACT: A field experiment was carried out during two winter seasons (2012 and 2013) at El-Noubaria, El-Behiera Governorate, Egypt, to evaluate the effect of soil inoculation with symbiotic N₂-fixing bacteria (a composite inoculum containing mixed culture "1:1" of *Azotobacter chroococcum* and *Azospirillum lipoferum*) on plant growth and yield of wheat crop grown newly reclaimed sandy soil. Foliar application of pink pigment facultative methylotrophic bacteria PPFMs (producing phytohormone) with either level of N-mineral fertilizer (60 and 120 kg N/fed), was also introduced.

The obtained results showed that inoculation with both N₂-fixers combined with PPFMs bacteria recorded the highest significant increases for all tested parameters of wheat growth, yield and yield components. Bacterial inoculation in combination with N- mineral fertilizers gave increase percentages of 25, 18, 8, 27, 12 and 6% for numbers of tillers (No/m²), weight of grains (g/plant), 1000 grains weight (g/1000grains), total biological yield (ton/fed.), grain yield (ton/fed.) and crude protein (%) as compared with mineral N- fertilize as such, respectively. Bacterial inoculation did support microbial population (total number of bacteria and count of each of *Azotobacter* and *Azospirillum*).

Key words: PGPR, N₂-fixers, *Triticum aestivum*, cereal, bacterial co-inoculation.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop and it is the major source of food in Egypt. So increasing wheat production is an essential national target to fill the gap between production and consumption.

Production could be increased through cultivation of high yielding cultivars and appropriate agronomic practices (Tawfik *et al.*, 2006). Throughout the growing season, plants are exposed to different stresses, *i.e.* drought, heat, salinity and low soil fertility, causing reductions in crop yield particularly in newly reclaimed area (Ali and Abo-El-wafa 2006). Extensive cultivation of wheat in the newly reclaimed soil in Egypt seemed to be imperative to circumvent the problem of insufficient wheat grain supply. However, intensive chemical fertilizers have introduced undesirable and same times catastrophic consequences by polluting air, soil and aquatic systems. The response of wheat crop to N-fixers reached 120 kg N/fed. (Abdel-warth, 2002). The efforts to decrease N-chemical fertilization by using biofertilizers

might both reduce the high costs and environmental pollution. Therefore, it is necessary to find out a correct and compatible level of nitrogen fertilizer with these biofertilizers. Inoculation with N₂-fixers, *i.e.* *Azotobacter chroococcum* and *Azospirillum lipoferum* have been widely used to inoculate non legume crops. They have proved to increase the yield of field cereal crops by about 15-25 %. Indeed, the N-biofertilizers is a cheap technique to produce plant protein, as well as they an important role in buildup soil fertility (Hegazi *et al.*; 1998., Mahmoud *et al.*, 2006 and Abdel-Warth *et al.*, 2010). Bacteria belonging to the genus methylbacterium, known as pink-pigmented facultative methylotrophic bacteria (PPFMs) are ubiquitous in nature and have been detected in various environments habits (corpe 1985 and Green 2001). PPFMs bacteria are aerobic, Gram-negative bacteria, able to grow on a wide range of multi-carbon substrates, as well as are known to produce auxins (Doronina *et al.*, 2002) and cytokinins (Koenig *et al.*; 2002 and Orf *et al.*, 2005).

The aim of this study was to investigate the effect of applying N₂-fixing bacteria as biofertilizers and/or (PPFMs) bacteria under N-mineral treatment, on some growth parameters, yield and yield components of wheat plants grown newly reclaimed sandy soil, as well as on the activity of rhizobacteria.

MATERIALS AND METHODS

A field experiment was carried out at El-Noubaria, Beheira Governorate in two winter seasons (2012 and 2013) to study the effect of some effective microorganisms on improving productivity of wheat plants. Some physical and chemical properties of the soil used are illustrated in Table (1) according to Page *et al.* (1982) and Klute (1986).

Compost was ploughed with the surface layer of the soil (0-20 cm) at a rate of 4ton/fed., two weeks before sowing. Calcium super-phosphate (15.5% P₂O₅) was added to all experimental area at a rate of 200 kg/fed. 15 day prior to cultivation. Nitrogen

fertilizer (Ammonium nitrate, 33.3% N) was added at two rates of 60 & 120 kg/fed., in two equal parts, after 30 and 60 days from sowing. Potassium sulphate (contains 48% K₂O) was added (50 kg/fed) throughout two equal split doses, after 30 and 60 days from planting.

The most active N₂-fixers *Azotobacter chroococcum* and *Azospirillum lipoferum* isolated and identified in Microbiology lab of the Desert Researches Center Cairo, Egypt. They were added in combination as soil application while the PPFMs *Methylobacterium* genera were isolated and purified in the Agricultural Microbiology Dept., Soil Water and Environmental Research Institute (SWERI), A.R.C., Giza, Egypt. The PPFMs were introduced as foliar application. Liquid cultures (48 hr old) at a rate of 10⁷ cfu/ml were applied with the irrigation water directly after sowing, then 21 and 45 days later on. The PPFMs bacteria were splashed at the same times.

Table (1): Some properties of the soil under investigation.

Properties	Analyses	Determinations	Values
Physical	Particle size distribution (%)	Coarse sand	57.18
		Fine sand	30.12
		Silt	9.85
		Clay	2.85
	Soil texture	Texture clay	Sandy
Chemical	Ca Co ₃ (%)		2.14
	pH (1:2.5 soil/water suspension)		8.4
	Total soluble salt	EC (dS m ⁻¹)	0.30
	Soluble cations (meq l ⁻¹)	Ca ⁺⁺	1.40
		Mg ⁺⁺	0.65
		Na ⁺	0.50
		K ⁺	0.45
	Soluble anions (meq l ⁻¹)	CO ⁻	-
		HCO ⁻	0.10
		Cl ⁻	0.91
		SO ₄ ⁻	1.99
	Available nutrients (mg kg ⁻¹)	N	24.00
		P	4.00
K		54.0	

Response of wheat plants to some biofertilization techniques in newly.....

Microbiological analysis of the rhizosphere soil of wheat plants was carried out for total bacterial count, azotobacters and azospirilla densities, by culturing on an Ashby's agar medium (Abdel-Malek and Ishac, 1968) and a Dobereiner's semi solid malate medium (Dobereiner *et al.*, 1976), respectively.

Wheat cultivar "Gamaiza 9" grains were sown in plots (3X4 m). Irrigation water used had a EC of 0.546 dSm^{-1} , which is considered as a good quality. At harvest, plants were collected to estimate the traits, *i.e.* plant height, number of grains/spike, 1000-grain weight and biological yield, according to the method reported by A.O.A.C. (2003).

The experimental treatments (T) used can be summarized as follows:

1. T1: without inculcation and amended with a half dose of N (60kg/fed.).
2. T2: without inculcation and amended with a full dose of N (120 kg/fed.).
3. T3: inoculation with *Azotobacter* + *Azospirillum* (soil application) + $\frac{1}{2}$ N (60 kg/fed.).
4. T4: PPFMs (foliar application) + $\frac{1}{2}$ N (60 kg/fed.).
5. T5: N₂-fixers+PPFMs+ $\frac{1}{2}$ N (60 kg/fed.).
6. T6: Inoculation with *Azotobacter* + *Azospirillum* (soil application) + N (120 kg/fed.).
7. T7: PPFMs (foliar application) + N (120 kg/fed.).
8. T8: N₂-fixers+ PPFMs + N (120 kg/fed.).

Statistical analysis "LSD at a level of 0.05" was carried out, according to Snedecor and Cochran (1982).

Chemical analysis of wheat grains was performed, after harvest, to determine nitrogen, phosphorus and potassium content, according to Cottenie *et al.* (1982).

RESULTS AND DISCUSSION

Concerning the effect of applying the two biofertilizers types (N-fixers and PPFMs) under both mineral N-fertilizer levels on some growth parameters of wheat plants. The results in Table (2) clearly showed that plants received higher mineral N in presence

of the biofertilizers recorded the highest values for plant height, number of tillers and number of spikes, those values were 126.7, 130.8 & 379 and 401, 312 & 342 for plant height, number of tillers and number of spikes on first and second season, respectively. Application of N₂-fixing bacteria alone or in combination with PPFMs as biofertilizers resulted in significance differences among all the tested parameters, compared to the mineral N treatments. On the other hand, the second season showed higher values for tested parameters than the first one.

Significant effects were found for each of spike length, number of grains, and weight of grains Table (3). The treatments receiving both bacterial inoculations recorded the highest values of spike length (17.1 cm), number of grains (54.8 g) and weight of gains (2.34 g), as compared with the other treatments undertaken.

Data presented in Table (4) show the effect of different bacterial inoculants (N₂-fixers + PPFM) on the total biological yield, grains yield and 100 – grains weight. Such parameters were significantly increased. The treatment which received both bacterial inoculations (N-fixers + PPFM) and fertilized with 120 kg N/fed. possessed the highest values of total biological yield (6.78 ton/fed.), grains yield (2.25 ton /fed.) and 1000 grain weight (57.82 g) compared to the other tested treatments.

Results of the grain contents of nitrogen, phosphorus, potassium, and protein, as well as the IAA content are presented in Table (4). With respect to the effect of inoculation with *Azotobacter* + *Azospirillum* and/ or PPFMs bacteria resulted marked increases in the mentioned parameters as compared with the uninoculated treatments receiving N-mineral fertilizer alone. Significant augmentations were found among the tested treatments, where the highest values were recorded for the treatments which received both bacterial inoculants and fertilized with 120kg N/fed., and these values were 1.94, 0.29, 0.65, 11.54 & 10.52 for nitrogen, phosphorus, potassium, cured protein and IAA, respectively.

Table (2): Wheat plant traits as affected by application of N₂-fixing bacteria and/or PPFMs bacteria under two levels of N-mineral fertilizer.

Treatment (T)		Parameter		Plant height (cm/plant)			Number of tillers (No./m ²)			Number of spike (No./m ²)		
		N-fertilizer (kg/fed.)	inocula									
		N ₂ fixers	PPFMs	S ₁	S ₂	mean	S ₁	S ₂	Mean	S ₁	S ₂	mean
T1	60	-	-	91.2	97.3	94.7	196	201	199	187	192	190
T2	120	-	-	119.9	121.3	118.6	310	325	318	280	301	291
T3	60	+	-	111.2	117.2	114.2	226	241	234	193	196	195
T4	60	-	+	98.7	101.3	100.0	276	293	285	198	211	205
T5	60	+	+	105.4	109.6	107.5	317	339	328	210	234	222
T6	120	+	-	120.8	122.6	121.7	338	351	345	287	298	293
T7	120	-	+	118.5	119.7	119.1	356	381	369	293	317	305
T8	120	+	+	126.7	130.8	128.8	379	401	390	312	342	327
mean				111.2	114.9	113.1	300	317	309	245	261	253
L.S.D. 0.05				6.28			36.76			47.52		

Table (3): Spike length, number of grains and weight of grains of wheat crop as affected by application N₂-fixing bacteria and/or PPFMs bacteria under two levels of N-mineral fertilizer.

Treatment (T)		Parameter		Spike length (cm/spike)			Number of grains (No. spike)			Weight of grains (g/ spike)		
		N-fertilizer kg/fed	Inocula									
		N ₂ fixers	PPFMs	S ₁	S ₂	mean	S ₁	S ₂	Mean	S ₁	S ₂	Mean
T1	60	-	-	9.8	9.9	9.9	23.3	25.1	24.2	1.09	1.13	1.11
T2	120	-	-	13.9	14.3	14.1	43.9	44.7	44.3	1.93	1.98	1.96
T3	60	+	-	16.2	10.6	10.4	29.8	30.2	30.0	1.31	1.37	1.34
T4	60	-	+	10.4	10.8	10.6	31.3	33.7	32.5	1.37	1.47	1.42
T5	60	+	+	11.3	11.7	11.5	33.4	35.8	34.6	1.47	1.58	1.53
T6	120	+	-	14.2	14.9	14.6	47.2	49.1	48.2	2.01	2.13	2.07
T7	120	-	+	15.3	16.2	15.8	49.3	51.6	50.5	2.11	2.24	2.18
T8	120	+	+	16.9	17.2	17.1	53.7	55.8	54.8	2.25	2.43	2.34
mean				12.8	13.2	13.0	38.9	40.8	39.9	1.69	1.79	1.74
L.S.D. 0.05				1.73			5.30			0.23		

Response of wheat plants to some biofertilization techniques in newly.....

Table (4): Biological yield, grains yield and 1000 grains weight of wheat crop as affected by application of N₂-fixing bacteria and/or PPFMs bacteria under two levels of N-mineral fertilizer.

Parameter Treatment (T)		inocula		Biological yield (ton/fed.)			Grain yield (ton/fed.)			Grain weight (g/1000 grain)		
		N ₂ fixers	PPFMs	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean
T1	60	-	-	2.54	2.65	2.60	0.79	0.81	0.80	40.61	43.72	42.17
T2	120	-	-	4.49	4.76	4.63	1.83	1.92	1.89	46.93	49.81	48.37
T3	60	+	-	2.79	2.94	2.87	0.93	0.98	0.96	42.51	44.22	43.37
T4	60	-	+	2.82	2.98	2.90	0.94	0.97	0.96	43.11	45.72	44.42
T5	60	+	+	3.60	3.79	3.70	1.20	1.23	1.22	44.25	47.27	45.76
T6	120	+	-	5.16	5.49	5.33	1.72	1.83	1.78	49.37	53.23	51.30
T7	120	-	+	5.95	6.16	6.06	1.95	2.02	1.99	50.22	55.17	25.70
T8	120	+	+	6.42	6.78	6.60	2.14	2.25	2.20	53.72	57.82	55.77
mean				4.22	4.44	4.33	1.44	1.50	1.47	46.34	49.62	47.98
L.S.D. 0.05				0.54			0.19			1.35		

Application of the bacterial inoculation did support yield production of wheat crop (Table 5), values appearing in Table (6) recorded increases of 25, 7, 18, 8, 27, 12, 6 & 25% for number of tillers, number of spikes, weight of spike grains 1000-grain weight, biological yield, grain yield, crude protein and IAA content. Similar findings were reported by Hussein and Radwan, (2001), that inoculated wheat grains with biofertilizers significantly increased the grain yield/fed, harvest index, 1000-grain weight and spike grain weight by 6.5, 3.4, 2.1 and 8.8%, respectively, rather than the non-biofertilized treatments. Mohmoud and Mohamed (2008) and Badran (2009) concluded that biofertilizers stimulated wheat growth and grain yield. Holland (1997) stated that, the activities of PPFMs could make a biochemically measurable and physiologically meaningful contribution to plant metabolites. Omer (2004) and Orf *et al.* (2005) found that PPFMs produced cytokine and other phytohormones, which stimulated the plant growth and development. In this respect, Shehata *et al.* (2006) and Orf *et al.*

(2014) reported that application of local isolates of PPFMs with other N₂-fixing bacteria gave higher records of all plant parameters and increased in productivity of legume crops tested.

Results of the rhizospheric bacteria shown in Tables (7&8) indicated that the initial numbers were 1.23×10^5 , 0.12×10^2 and 0.05×10^2 for the total bacteria, *Azotobacter* and *Azospirillum* respectively. Data in Table (7) revealed that application of the bacterial inoculants did support the microbial counts and scored higher values as compared with the uninoculated treatments. Moreover, introduction of PPFMs bacteria had a superior effect compared to the N₂-fixing bacteria alone or in combination with PPFMs. These results are in agreement with those reported by Subba Rao (1988), Abd El-Ghany *et al.* (2010) and Abdel Warth *et al.*, (2010), that bacterial inoculation improved soil fertility, increase the number and biological activities of desired microorganisms in root environment.

TABLE 5

Response of wheat plants to some biofertilization techniques in newly.....

TABLE 6

Table (7): Total bacterial counts of soil planted with wheat plants as affected by application of N₂-fixing bacteria and/or PPFMs bacteria under two levels of N-mineral fertilizers.

Parameter Treatment				Total bacterial counts cfu/g dry soil (- X 10 ⁵)			Azotobacter counts cfu/g dry soil (- X 10 ⁵)			Azospirillum counts cfu/g dry soil (- X 10 ⁵)		
	N-fertilizer kg/fed	inocula		S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean
		N ₂ fixing	PPFMs									
T1	60	-	-	10.25	11.31	10.78	5.11	6.50	5.81	1.43	1.48	1.46
T2	120	-	-	12.37	14.51	13.44	15.93	16.53	16.23	4.93	5.14	5.04
T3	60	+	-	23.72	25.77	24.75	12.61	13.73	13.17	7.31	8.11	7.71
T4	60	-	+	24.85	25.93	25.39	9.72	10.13	9.93	5.37	6.52	5.95
T5	60	+	+	27.93	28.11	28.02	12.70	14.53	13.62	9.31	10.22	9.77
T6	120	+	-	26.31	28.93	27.62	16.37	17.91	17.14	11.72	11.89	11.80
T7	120	-	+	28.22	28.75	28.49	16.85	15.22	15.04	10.67	10.72	10.70
T8	120	+	+	29.11	29.88	29.50	17.81	18.22	18.02	12.75	13.21	12.98
mean				22.85	24.15	23.50	13.14	14.10	13.62	7.94	8.41	8.18
Initial count				1.15X10 ⁴			0.12X10 ⁴			0.05X10 ⁴		

Table (8): Increases percent of total number for various (RMO) bacteria at soil planted with inoculated wheat plants.

Parameter Treatment	Total bacterial counts cfu/g dry soil (- X 10 ⁵)		Azotobacter counts cfu/g dry soil (- X 10 ⁵)		Azospirillum counts cfu/g dry soil (- X 10 ⁵)	
	Value	%	Value	%	Value	%
Initial count	1.23	-	0.12	-	0.05	-
Mineral fertilizers	12.11	88	11.02	90.8	3.25	64.0
60 kg N + inoculation	26.05	202	12.24	101.0	7.81	155.2
120 kg N + inoculation	28.54	222	16.72	138.3	11.83	235.6

Response of wheat plants to some biofertilization techniques in newly.....

On the other hand, the treatment which received 120 kg N/fed and inoculated with a combination of N₂ fixing and PPFMs bacteria gave the highest bacterial counts, to show the values 29.50, 18.02 and 12.94 for total, *Azotobacter* and *Azospirillum*, in both seasons, respectively. It is worthy to note that the percentages of increase were due to the applied N-mineral fertilizer and the two bacterial treatments together with 60 kg N/fed. or 120 kg N /fed., referring to the initial counts of each bacterial agent (Table 8). Such percentages of increase were 88, 202 and 222, 90.8, 101.0 and 138.3, 64.0, 155.2 and 235.6 for the numbers of *Azotobacter* and *Azospirillum*, respectively. These results are in harmony with those obtained by Pondy *et al.* (1998), Abotaleb *et al.* (2002), Mahmood *et al.* (2006), Anjum *et al.* (2007) and Abd el-Warth *et al.* (2010) who reported that the bacterial inoculation had an activation effect on the population of both total bacteria and diazotrophic bacteria and increased their numbers more than 50%.

This work leads us to conclude that application of N-fertilizer at 120kg N/fed. combined with a mixed biofertilizers inoculation (N₂ fixers and PPFMs bacteria) to wheat grains improved the crop yield, as well as enhanced soil fertility and increased the number and biological activities of rhizospheric microorganisms.

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إستجابة نباتات القمح لبعض تقنيات التسميد الحيوي في الأراضي الرملية المستصلحة حديثاً

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الملخص العربي

أجريت تجربة حقلية خلال موسمي ٢٠١٢-٢٠١٣ في النوبارية-محافظة البحيرة-مصر، وذلك لدراسة تأثير التلقيح البكتيري للأرض بمثبات الأزوت الجوي اللاتكافلية (لقاح مختلط من بكتريا الأزوتوبكتريا كروكوم وبكتريا الأزوسبيريللم لبيوفيرم بنسبة ١:١)، في وجود أو عدم وجود البكتريا القرمزية المتغذية علي الميثانول والمنتجة للهرمونات النباتية (وذلك كمعاملة رش) في وجود مستويين من التسميد النيتروجيني المعدني ٦٠، ١٢٠ كج/ن/فدان علي النمو والمحصول ومكوناته لنباتات القمح. وأيضاً دراسة تأثير التلقيح البكتيري علي التجمع الميكروبي في أرض التجربة.

وأوضحت النتائج المتحصل عليها أن التلقيح البكتيري قد أعطي أعلى القيم المتحصل عليها لقياسات نمو النباتات والمحصول ومكوناته. حيث سجل التلقيح البكتيري في وجود التسميد المعدني فروقاً معنوية وزيادات بلغت ٢٥-١٨-٨-٢٧-١٢ و ٦% وذلك بالنسبة لكل من التفرع (للمتر المربع) ووزن الحبوب (جرام/نبات) ووزن الحبة (١٠٠٠ حبة والمحصول البيولوجي (طن/فدان) وحصاد الحبوب (طن/فدان) وأيضاً نسبة البروتين علي التوالي وذلك مقارنة باستخدام السماد النيتروجيني المعدني بمفرده.

هذا وقد أدي التلقيح البكتيري إلي دعم التجمع الميكروبي لمنطقة جذور نباتات القمح في الموقع التجريبي حيث سجلت زيادات بلغت ٢٢٢ و ١٣٨.٣ و ٢٣٥.٦ لكل من العدد البكتيري الكلي وعدد الأزوتوبكتريا وعدد الأزوسبيريللم علي التوالي وذلك في وجود ١٢٠ كج/ن/فدان مقارنة بالعدد الأولي والمسجل قبل زراعة الموقع التجريبي وبصفة عامة أدي التسميد الحيوي (التلقيح البكتيري) إلي الحصول علي قيم عالية لمحصول القمح ومكوناته هذا بالإضافة إلي تحسين خصوبة التربة وزيادة أعداد التجمع الميكروبي والنشاط الحيوي في منطقة الجذور.

Table (5): Nitrogen, phosphorus, potassium contents, crude protein and IAA content of wheat grains as affected by application of N₂-fixing bacteria and/or PPFMs bacteria under two levels of N-mineral fertilizer.

Parameter Treatment (T)		N-fertilizer kg/fed		inocula		Nitrogen (%)			Phosphorus (%)			Potassium (%)			Crude protein (%)			IAA (mg/ml)		
						S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean
		N ₂ fixers	PPFMs	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean	S ₁	S ₂	mean		
T1	60	-	-	1.60	1.62	1.61	0.21	0.21	0.21	0.49	0.51	0.50	9.52	9.64	9.58	6.77	7.05	6.91		
T2	120	-	-	2.10	2.11	2.11	0.29	0.31	0.30	0.79	0.81	0.80	12.49	12.55	12.53	10.60	11.10	10.85		
T3	60	+	-	1.71	1.73	1.72	0.22	0.24	0.23	0.52	0.52	0.53	10.17	10.29	10.23	9.44	9.63	9.54		
T4	60	-	+	1.77	1.79	1.78	0.23	0.26	0.25	0.54	0.57	0.56	10.53	10.65	10.59	9.49	9.68	9.59		
T5	60	+	+	1.82	1.83	1.83	0.25	0.27	0.26	0.58	0.59	0.59	10.83	10.89	10.86	9.77	9.87	9.82		
T6	120	+	-	2.13	2.15	2.14	0.31	0.34	0.33	0.67	0.69	0.68	12.67	12.79	12.73	11.87	12.10	11.99		
T7	120	-	+	2.11	2.16	2.14	0.32	0.36	0.34	0.73	0.75	0.74	12.55	12.85	12.70	12.45	12.65	12.55		
T8	120	+	+	2.18	2.21	2.20	0.35	0.38	0.37	0.77	0.78	0.78	12.97	13.15	13.06	12.92	12.98	12.95		
mean				1.93	1.95	1.94	0.28	0.30	0.29	0.64	0.65	0.65	11.47	11.60	11.54	10.41	10.63	10.52		
L.S.D. 0.05				0.07			0.05			0.04			0.28			0.23				

Table (6): Increases of some yield parameters of mineral N fertilized wheat plants as affected by application of bacteria inoculation.

Parameter	Number of tiller (No./m ²)		Number of spike (No./m ²)		Weight of grains (g/spike)		1000-grain weight (g)		Biological yield (ton/fed.)		Grain yield (ton/fed.)		Protein content (%)		IAA content (mg/ml)	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
N-mineral fertilizer	259	-	241	-	1.54	-	45.27	-	3.62	-	1.35	-	11.06	-	8.88	-
N-mineral fertilizer + inoculation	325	25	259	7	1.81	18	48.89	8	4.58	27	1.51	12	11.70	6	11.07	2.5

