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DO CYANOBACTERIA AND EFFECTIVE MICROORGANISMS AFFECT WHEAT YIELD AND GRAIN QUALITY

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ABSTRACT

Recently, a great attention is paid in establishing concept of the associations between wheat plants and a variety of N_2-fixing microorganisms. This phenomenon has entered the scientific scene arising from the prospects and the possibilities of their potentially application. . In this work, cyanobacteria inoculant (SBI) and the effective microorganisms (EM) were applied to wheat in a field experiment as single or dual inoculants under different levels of nitrogen. Results revealed that cyanobacteria inoculant (SBI) combined with EM application exhibited an economical view that it can save about 50 % of the mineral nitrogen amounts required for wheat crop production especially. The trend was noticed when SBI combined with EM which recorded a grain yield not significantly different from that obtained by the full recommended nitrogen dose in wheat cultivation. Wheat inoculation with cyanobacteria and EM as single or dual inoculants has also enhanced the NPK- uptake by wheat plant and wheat grains quality.

Keywords: Cyanobacteria, EM, wheat, NPK uptake, quality, grains.

INTRODUCTION

The use of the conventional chemical farming methods, which substantially increased crop production, was once regarded as a kind of agriculture revolutions which would solve all problems relating to producing sufficient food for the ever growing world population.

However this belief was later over-shadowed by the emergence of numerous environmental and social problems associated with the heavy use of agrochemicals in intensive farming systems.

Conventional farming methods are generally associated with degradation of the environment.

Among other things, soil degradation is one of the most serious problems which affect crop production. Increasing prices of agrochemicals especially nitrogen often leave farmers with low profit. Uncertain availability of those agrochemicals, especially in the developing countries such Egypt, is often a serious constraint for the farmers in their attempt to increase crop production. Such problems have directed the attention of the agriculturists world-wide to seek alternative methods of farming.

In attempting to develop productive, profitable and sustainable agriculture systems, several agriculturists turn to farming methods which are based on biotechnologies. Two of the several approaches to achieve this goal are using the nitrogen fixing cyanobacteria and the effective microorganism (EM) in order to improve crop productivity and soil fertility.

The use of nitrogen fixing cyanobacteria ensures entirely or partially the mineral nitrogen, while EM is expected to enhance the availability of soil nutrients and humus formation and to control certain plant diseases and pathogens (Myint, 1999).

There is a great deal of interest in creating novel association between agronimically important plants, partially cereals such wheat and N_2-fixing microorganisms including cyanobacteria (Spiller *et al*. 1993). The heterocystous cyanobacterium *Nostoc sp*. is usual among characterized cyanobacteria in its ability to form tight association with wheat roots and penetrate both roots epidermis and cortical intracellular space (Gantar *et al.* 1991).

The N_2- fixed by *Nostoc Sp.* in association with wheat is takes up by the plant and sports its growth, improving grain yields and grain quality (Gantar *et al.* 1995).

The present work is to study the effect of cyanobacteria and effective-microorganism as biofertilizers on wheat productivity, NPK uptake of wheat grains and straw and wheat grain quality as well as the availability of NPK in the remained soil.

MATERIALS AND METHODS

A field trial was conducted at El Ismailia Research station, Agricultural Research

Center (2002 / 2003) to study the effect of both cyanobacteria inoculation and effective microorganisms (EM) application either alone or in combination on wheat (*Triticum aestivum* cv. Sakha 69) growth under different mineral nitrogen fertilizer levels as urea of full recommended dose (FRD) (80 kg N), 50% (FRD) (40 kg N) and 25 % (FRD) (20 kg N). The physico-chemical analysis (Black, 1965) of the experimental soil is as shown in Table (1).

Table (1): Some chemical and physical analyses of the investigated soil

pH (1:2.5)	EC dS/m	Soluble cations (meq/L)				Soluble anions (meq/L)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
8.14	1.4	4.56	2.60	3.07	0.36	--	6.60	2.83	1.16

Coarse sand %	Fine sand %	Silt %	Clay %	$CaCO_3$ %	Textural class
76.18	15.17	2.35	6.30	1.5	Sandy

Available N (ppm)	Available P (ppm)	Available K (ppm)
20	4	49

The experimental field was prepared by ploughing and puddling, and then divided into 36 plots (3m x 3m each) to represent 12 treatments in three replicates arranged in statistical split plot design. Herein, nitrogen fertilizer represents the main plot in three treatments, while biofertilizers as single or dual inoculants and the control treatment (with nitrogen and without biofertilizers) represent the sub plot. Uniform application of phosphate @ 200 kg fed^{-1} as super- phosphate (15 % P_2O_5) and potassium @ 100 kg fed^{-1} potassium sulphate (48% K_2O) were done as basal to each plot. Nitrogen as urea (46% N) was applied in three split doses. Cyanobacteria inoculant (SBI) at the rate of 15 kg dried soil based inoculum was executed 7 days after sowing of wheat seeds, While (EM) was sprayed on the plants two weeks after sowing at the rate of 40 L fed^{-1} in three split doses monthly starting from cultivation. Irrigation was carried out every three days using the sprinkler system.

The soil based cyanobacteria inoculum (SBI) is kindly provided by The Agricultural Microbiology Department, Soils, Water and Environment Research Institute, Agricultural Research Center, Giza.

Effective microorganisms (commonly termed EM) was developed in the 1970, s at the university of Ryukyus, Okinawa, Japan. The inception of the technology was based on blending multitude of microbes, and was subsequently refined to include principal types of organisms commonly found in all ecosystems, namely lactic acid bacteria, photosynthetic bacteria, yeasts, actinomycetes and fungi. These were blended in molasses or sugar medium and maintained at low pH under ambient conditions (kato *et al*. 1999).

At harvest, wheat plants were cut just above the soil surface to determine the wheat yield components, wheat grain quality such as protein % (A. A.O.A.C., 1960), carbohydrate % (Dubois *et al*., 1965), gluten % (A. A. C. C., 1983), wheat flour extract % (A. A. O. A. C., 1985) and ash % (A. A. O.A.C., 1980), NPK by wheat grain and straw (Chapman and Pratt, 1961). The remained soil was sampled and subjected to evaluate the available NPK (Jackson, 1973). Data obtained were statistically analyzed as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The nitrogen fixing cyanobacteria inoculation to wheat is recently established to alternate partially or entirely the mineral nitrogen utilization (Mussa *et al*. 2003), while effective microorganisms is recommended to enhance soil characteristics degraded due to conventional farming methods (Sangakkara, 1999).

Wheat yield components

Data in Table (2) indicate the effect of cyanobacteria association EM and N fertilization levels on wheat yield components. All the treatments increased significantly the wheat grain yield over the control treatments. The highest grain yield (1295.34 kg fed^{-1}) attained by cyanobacteria plus EM treatments combined with full dose of mineral N (80 kg N fed^{-1}) followed by 1274.77 kg fed^{-1} for cyanobacteria + EM combined with ½ full dose of mineral nitrogen (40 kg N fed^{-1}). However, there was no significant difference between these two treatments.

The application of full nitrogen dose gave significantly the highest wheat grain yield (1043.91 kg fed^{-1}) compared with the other two levels of nitrogen (¼ and ½ N dose).

Same behavior exhibited by grain yield was observed for straw yield indicating the highest straw yield (3.31 tons fed^{-1}) for the treatment cyanobacteria plus EM under full nitrogen dose and followed by (2.97 tons fed^{-1}) for cyanobacteria plus EM under ½ N level treatment without significant different between each others.

Towards nitrogen application also full dose recorded the highest significant straw yield (2.68 tons fed $^{-1}$) due to full N dose application compared with the other two nitrogen levels.

1000-grain weight showed an indefinite trend in response the tested treatments. However, this notice depends on the number of panicles plant^{-1} which correlated drastically on the grain yield.

Table (2): Effect of cyanobacteria inoculation, effective micro-organisms (EM) as single or dual inoculants and N-fertilization on wheat yield components.

N-fertilizer level	Treatments				Means
	control	Cyanobacteria	EM	Cyanobacteria +EM	
	grain yield kg fed^{-1}				
1/4 N	574.28	780.96	845.49	962.25	790.75
1/2 N	736.09	869.57	866.46	1274.77	936.72
full dose N	872.10	993.48	1014.70	1295.34	1043.91
Means	727.49	881.34	908.88	1177.45	
L.S.D. at 5% N:	96.77				
Treatment:	72.26				
Interaction:	144.00				
	straw yield ton fed^{-1}				
1/4 N	2.61	2.33	2.59	2.28	2.45
1/2 N	2.41	3.03	2.42	2.97	2.71
full dose N	2.69	2.49	2.21	3.31	2.68
Means	2.57	2.62	2.41	2.85	
L.S.D. at 5% N:	0.31				
Treatment:	0.29				
Interaction:	0.53				
	1000 grains weight (g)				
1/4 N	45.87	53.30	48.77	49.00	49.24
1/2 N	46.97	53.83	54.50	48.30	50.90
full dose N	42.63	49.97	40.10	50.90	45.90
Means	45.16	52.37	47.79	49.40	
L.S.D. at 5% N:	2.26				
Treatment:	3.92				
Interaction:	4.44				

NPK uptake by wheat grains

Table (3) revealed that inoculation with cyanobacteria plus EM application under full nitrogen dose gave the highest N uptake amount (22.03 kg N fed $^{-1}$) with no significant difference with that recorded by cyanobacteria plus EM treatment under ½ N dose (21.67 kg N fed $^{-1}$). Due to nitrogen application alone, there was no significant difference in N uptake values obtained by either ½ or full N dose treatments. Their respective mean N uptake values were 15.71 and 16.87 kg N fed $^{-1}$.

Phosphorus uptake and K uptake indicated the same trend in response to the tested treatments as shown in N uptake. In case of P uptake the highest value of 2.17 kg P fed $^{-1}$ was not significantly differ from 2.07 kg P fed $^{-1}$ for cyanobacteria plus EM plus ½ N dose and cyanobacteria plus EM plus full N dose, treatments, respectively. Likewise, with K uptake, the highest value of 6.63 kg K fed $^{-1}$ was not significantly different from that of 6.35 kg K fed $^{-1}$ for cyanobacteria plus EM + ½ N dose and cyanobacteria + EM + Full dose treatments, respectively.

Table (3): Effect of cyanobacteria inoculation, effective micro-organisms (EM) as single or dual inoculants and N-fertilization on NPK uptake by wheat grains.

N-fertilizer level	Treatments				Means
	control	cyanobacteria	EM	cyanobacteria +EM	
	N-uptake kg fed^{-1}				
1/4 N	8.04	10.15	15.20	16.36	12.44
1/2 N	12.51	14.78	13.86	21.67	15.71
full dose N	18.31	11.92	15.22	22.03	16.87
Means	12.95	12.28	14.76	20.02	
L.S.D. at 5% N:	1.45				
Treatment:	1.20				
Interaction:	2.29				
	P-uptake kg fed^{-1}				
1/4 N	0.75	1.17	1.18	1.35	1.11
1/2 N	1.18	1.74	1.39	2.17	1.62
full dose N	1.35	1.49	1.93	2.07	1.71
Means	1.09	1.47	1.50	1.86	
L.S.D. at 5% N:	0.16				
Treatment:	0.13				
Interaction:	0.24				
	K-uptake kg fed^{-1}				
1/4 N	2.99	3.75	4.22	4.62	3.90
1/2 N	3.98	4.87	3.99	6.63	4.87
full dose N	4.45	5.17	5.38	6.35	5.34
Means	3.81	4.60	4.53	5.87	
L.S.D. at 5% N:	0.52				
Treatment:	0.38				
Interaction:	0.76				

For nitrogen application means, the priority in NPK uptake by wheat grains was for the use of full N dose. Their respective mean values, were 16.87 kg N fed $^{-1}$ (N uptake), 1.71 kg P fed $^{-1}$ (p-uptake) and 5.34 kg K fed $^{-1}$ (K-uptake).

NPK uptake by wheat straw

Table (4) indicate that N uptake value recorded by the cyanobacteria + EM + ½ N dose (14.83 kg N fed $^{-1}$) was not significantly different from that recorded by Cyanobacteria + EM + full N dose treatment (16.55 kg N fed $^{-1}$). In contrast, P uptake value of 4.15 kg P fed $^{-1}$ (cyanobacteria + EM + ½ N dose) was significantly higher than that recorded by cyanobacteria + EM + Full N dose treatment (2.98 kg P fed $^{-1}$).

Same observations were noticed by K –uptake, that the K- uptake value recorded by the treatment of cyanobacteria + EM + Full N dose (22.18 kg K fed $^{-1}$) was significantly higher than that recorded by cyanobacteria + EM + ½ N dose treatment (16.91 kg k fed $^{-1}$) .

Table (4): Effect of cyanobacteria inoculation, effective micro-organisms (EM) as single or dual inoculants and N-fertilization on NPK uptake by wheat straw.

N-fertilizer level	Treatments				Means
	control	cyanobacteria	EM	cyanobacteria +EM	
	N-uptake kg fed^{-1}				
1/4 N	13.05	27.94	10.37	11.95	15.83
1/2 N	24.18	30.27	14.54	14.83	20.96
full dose N	16.16	14.94	13.38	16.55	15.26
Means	17.80	24.38	12.76	14.44	
L.S.D. at 5% N:	2.65				
Treatment:	2.15				
Interaction:	4.14				
	P-uptake kg fed^{-1}				
1/4 N	1.55	3.51	2.34	1.36	2.19
1/2 N	4.10	4.52	2.91	4.15	3.92
full dose N	2.24	1.24	4.01	2.98	2.62
Means	2.63	3.09	3.09	2.83	
L.S.D. at 5% N:	0.59				
Treatment:	0.43				
Interaction:	0.87				
	K-uptake kg fed^{-1}				
1/4 N	16.18	12.82	14.65	17.55	15.30
1/2 N	25.34	19.37	12.60	16.91	18.56
full dose N	17.77	19.67	15.84	22.18	18.87
Means	19.76	17.29	14.36	18.88	
L.S.D. at 5% N:					
Treatment:	3.15				
Interaction:	2.32				

Wheat grain Quality

Results in (Table 5) revealed that increasing nitrogen levels from ¼ N to full – N dose increased significantly the carbohydrate wheat grain percentages. The highest carbohydrate percentage of 45.43 due to N application attained by the treatment received full- N dose.

Both cyanobacteria and EM application either each alone or in combination under different N levels increased significantly wheat grain carbohydrate percentage over the control treatment received ¼ N dose. However the highest carbohydrate percentage (46.50) was obtained by the grain wheat treated with cyanobacteria + EM combined with full N dose. This high carbohydrate percentage was not significantly different from that recorded by the treatment cyanobacteria + EM + ½ N dose (46.24).

Apart from nitrogen application both cyanobacteria and EM application each alone or in combination did not exhibit any significant difference in wheat carbohydrate percentages due to the tested treatments.

Increasing the nitrogen level from ¼ N up to full – N dose increased significantly the flour extract ratio recording the highest percentage of 71.03 due to full-N dose treatment. Inferior from nitrogen application, all the treatments increased significantly the flour extract percentage over the control treatment. The highest extract percentage (70.80) was obtained by the use of EM alone followed by 70.70 for cyanobacteria combined with EM without significant difference between each others.

On the other respect, the interaction effect between cyanobacteria inoculation and EM application each alone or both together under the effect of different nitrogen levels exhibited the highest extract percentage of 72.00 for the treatment received full-N dose combined with cyanobacteria inoculation. This high extract percentage did not differ significantly from that of 71.33 recorded by the use of cyanobacteria inoculation combined with EM plus full-N dose.

Protein percentage in wheat grains had not affected significantly by any of nitrogen fertilizer, cyanobacteria and EM application even when both cyanobacteria and EM each alone or in combination were tested under the effect of the fertilizer nitrogen levels. However, the highest protein percentage of 10.96 was due to the treatment received EM + full-N dose followed by 10.90 (cyanobacteria + full-N dose) and then 10.80 (full-N dose).

Dry gluten in wheat grains did not exhibit any significant difference due nitrogen applied alone. The highest dry gluten percentage (11.87) attained by the use of full-N dose followed by 10.55 and 10.26 for ¼ N dose and ½ N dose treatment, respectively.

Inferior to nitrogen application, cyanobacteria inoculation combined with EM application gave the highest dry gluten percentage (11.43) in wheat grains followed with 11.0, 1.79 and 10.70 for EM, cyanobacteria inoculation and control treatment, respectively. Nevertheless, only the dry gluten percentage of 11.43 recorded in response to the use of cyanobacteria + EM was significantly different from that of the control treatment (10.70%). The use of nitrogen along with either cyanobacteria inoculation or EM each alone or in combination revealed that the highest dry gluten percentage in wheat grains of 12.04 was recorded due to the use of cyanobacteria + EM + full-N dose. This high dry gluten percentage was significantly less than that recorded by the control received ½ N dose (13.98%).

Nitrogen application alone had achieved the highest wheat ash percentage of 1.55 when nitrogen applied as full-N dose. This high ash percentage was significantly higher than those of 1.37 and 1.48% for both ¼ N and ½ N –dose, respectively.

Due to the use of either cyanobacteria inoculation or EM each alone or in combination, it was clear that highest ash percentage (1.54) was obtained when cyanobacteria accompanied with EM. However, this high percentage was significantly higher than those recorded by the other treatments.

The interaction effect of nitrogen application along with cyanobacteria and \ or EM each alone or in combination exhibited the highest wheat ash percentage of 1.60 for cyanobacteria + EM + full-N dose treatment. This high percentage was significantly higher than the other interaction treatments except for that of 1.52% recorded by the use of cyanobacteria + EM + ½ N dose treatment.

Table (5): Effect of cyanobacteria inoculation, effective micro-organisms (EM) as single or dual inoculants and N-fertilization on wheat grain quality.

N-fertilizer level	Treatments				Means
	control	cyanobacteria	EM	Cyanobacteria +EM	
	% carbohydrate				
1/4 N	34.43	35.16	33.61	33.39	35.15
1/2 N	41.25	42.35	45.28	46.24	43.78
full dose N	43.65	45.22	41.33	46.50	45.43
Means	39.78	40.91	43.07	42.04	
L.S.D. at 5% N:	1.99				
Treatment:	2.17				
Interaction:	6.75				
	%wheat flour extract				
1/4 N	63.75	69.71	70.15	70.31	68.48
1/2 N	69.36	67.89	70.68	70.63	69.64
full dose N	67.80	72.00	69.68	71.33	71.03
Means	66.97	69.87	70.80	70.70	
L.S.D. at 5% N:	1.41				
Treatment:	1.40				
Interaction:	1.86				
	% protein				
1/4 N	10.36	10.84	10.01	10.06	10.82
1/2 N	10.24	10.14	10.26	10.30	10.24
full dose N	10.80	10.90	10.96	10.30	10.74
Means	10.40	10.63	10.41	10.13	
L.S.D. at 5% N:	0.27				
Treatment:	0.29				
Interaction:	0.50				
	% dry Gluten				
1/4 N	10.17	10.23	11.73	11.07	10.55
1/2 N	13.98	10.44	11.03	11.17	10.26
full dose N	11.00	11.70	11.72	12.04	11.87
Means	10.70	10.79	11.03	11.43	
L.S.D. at 5% N:	1.76				
Treatment:	0.54				
Interaction:	0.30				
	% ash				
1/4 N	1.36	1.40	1.36	1.40	1.37
1/2 N	1.40	1.48	1.50	1.52	1.48
full dose N	1.50	1.53	1.56	1.60	1.55
Means	1.42	1.47	1.46	1.54	
L.S.D. at 5% N:	0.07				
Treatment:	0.06				
Interaction:	0.10				

In respect to available NPK amounts remained in soil after wheat harvesting, results in Table (6) indicated that available-N significantly increased in response to increasing nitrogen fertilizer doses over ½ N dose with priority to ½ N-dose treatment, which recorded 126.25 ppm available N.

Apart from nitrogen doses, cyanobacteria inoculation combined with EM application had achieved the highest available-N amounts (116.6 ppm). This high available-N amount was significantly different from that recorded by either cyanobacteria (105.00 ppm-N) or EM (103.33 ppm-N) treatments each applied alone.

Both cyanobacteria, EM each alone or in combination when being affected with the different fertilizer-N dose showed the highest available-N amount (140.00 ppm) for the treatment received cyanobacteria +EM + ½ N dose. However, this high amount was significantly exceeded all other interacted treatments.

Available phosphors amounts decreased significantly in response to nitrogen fertilizer doses, since they recorded less amounts of 6.61 and 6.99 ppm than that of 8.43 ppm for ½ , full and ¼ N-dose treatments, respectively.

Cyanobacteria, and EM applied each alone or in combination, gave the highest significant available phosphorus amount of 8.63 ppm (EM treatment alone) which was higher than those of 6.82 and 7.93 ppm for cyanobacteria + EM and EM treatments, respectively. However, the nitrogen, cyanobacteria and EM relations gave the highest significant available-P amount (11.4 ppm) for EM combined with ¼ N-dose compared to the other interaction treatments except for cyanobacteria combined with ¼ N-dose (9.00 ppm-P) treatment.

Available potassium amounts had fluctuated between decrease in response to ½ and full nitrogen dose compared to ¼ N-dose application. Nevertheless, the highest available-K amount of 19.75 ppm (full-N dose) was significantly higher than that recorded by ½ N dose (76.50ppm-K) but did not than that of 89.25 ppm-K for ¼ N-dose treatment.

On the other hand, EM applied alone had achieved the available-K amount (95.00 ppm) being significantly higher than those of cyanobacteria (89.33ppm-K) and cyanobacteria + EM (68.00 ppm-K) treatments.

Nitrogen, cyanobacteria and EM interactions resulted in the highest significant available-K amount of 118.00 ppm more than those recorded by the other interaction relations.

These results are in agreement with those described by (Abd-Alla *et al.,* 1994 and Mussa, *et al.,* 2003) who attributed the increase in wheat yield components in the cyanobacteria inoculated treatments to the substantial increases in N_2 fixation in soil due to nitrogenase activity of the cyanobacteria succeeded to create tight association with the roots of wheat plants. They also added that cyanobacteria inoculation led to soil structure improvement which being reflected on soil fertility and consequently on cultivated crop.

Significant increase was found in all wheat yield parameter with application of EM was applied along with ½ recommended nitrogen dose producing (2831 kg grains ha^{-1}) very clause to full-recommended nitrogen dose (3017 kg grains ha^{-1}) (Hussain *et al*., 1999). These observations are in parallel with the results in this study. On other respect, Increasing the nutrient uptake by wheat grain and straw in response to the use of both EM and cyanobacteria as biofertilizer separately was confirmed by those of Abd El Rasoul *et al.,* (2003) and Mussa *et al.* (2003) who indicated that spraying both EM and nitrogen fixing biofertilizers individually had significantly increased N, P and K uptake by grains and straw over the control treatments.

The use of cyanobacteria along with EM plus full-N dose had achieved grains and straw yields, NPK uptake by grains and straw very close to and not significantly different from those achieved by same treatments under the influence of ½ N dose. This trend are in parallel to what revealed by El Mancy *et al.* (1997) who found that combination between biofertilizers with reduced amount of the mineral nitrogen can lead to saving chemical-N fertilizer (about 50 %) and improving NPK uptake by rice grains and straw.

Table (6): Effect of cyanobacteria inoculation, effective micro-organisms (EM) as single or dual inoculants and N-fertilization on soil available nitrogen, phosphorus and potassium after wheat harvesting.

N-fertilizer level	Treatments				Means
	Control	**Cyanobacteria**	**EM**	**cyanobacteria +EM**	
	Available nitrogen (ppm)				
¼ N	90	100	80	100	92.50
1/2 N	120	125	120	140	126.25
full dose N	80	90	100	110	95.00
Means	96.66	105	103.33	116.6	
L.S.D. at 5% N:	2.65				
Treatment:	2.14				
Interaction:	4.14				
	Available phosphorus (ppm)				
1/4 N	7.4	9.0	11.4	5.90	8.43
1/2 N	4.16	8.3	6.9	7.07	6.61
full dose N	6.34	6.5	7.6	7.50	6.99
Means	5.97	7.93	8.63	6.82	
L.S.D. at 5% N:	1.40				
Treatment:	1.16				
Interaction:	2.50				
	available potassium(ppm)				
1/4 N	103	110	86	58	89.25
1/2 N	70	79	81	76	76.50
full dose N	100	79	118	70	91.75
Means	91	89.33	95	68	
L.S.D. at 5% N:	3.54				
Treatment:	3.09				
Interaction:	6.93				

Inoculation with the nitrogen fixing *Azospirillum* to wheat as biofertilizer combined with ½ recommended N dose increased significantly grain and straw yield and NPK- uptake by grains and straw, improved the grain quality (protein, dry gluten and flour extract percentages) compared to the control without inoculation (EL-Kassas, 2002).

The use of cyanobacteria and EM enhanced the chemical properties of the wheat post harvest remained soil. Mandal *et al.* (1999) emphasized that inoculation with cyanobacteria might help to regenerate quickly and improve soil structure. However, SBI are known to excrete extracellularly a number of compounds like polysaccharides, peptides, lipids….etc. during their growth in soil particles, and hold / glue them together in the form of micro-aggregates being a reason to improve the nutrient availability in soil. EL- Kassas (2002) found that Inoculation with the nitrogen fixing *Azospirillum* to wheat increased the soil *Azospirilla* and other microbial population including fungi, actinomycetes and *Azotobacter* , which consequently increased wheat grain yield, wheat grain NPK uptake, wheat grain protein and wheat grain quality due to the nitrogen fixation efficiency of these microorganisms.

Frighetto *et al.* (1999) confirmed that the use of EM has improved enhancement in soil biological and chemical properties which ensure not only organic and biological sources of the essential nutrients supply but also show some positive interaction with chemical fertilizers through increasing their efficiency and thereby reducing the environmental hazards.

Generally, It could be concluded that the use of cyanobacteria inoculation technology combined with EM along with one half of the recommended nitrogen dose in wheat production (especially in the areas with new reclaimed soil such as in this study) can enhance grains and straw yields, grains quality, NPK-uptake by grains and straw, and improve the soil nutrient status of the soil remained after wheat harvesting. However, this study need to be confirmed through its execution in different locations in Egypt, with special concern with effective microorganisms application.

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هل تؤثرالسيانوبكتريا والميكروبات الفعالة على محصول القمح وصفات الحبوب

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***معهـد بحـوث الأرا ضـى والميـاة والبيئـة- مركـز البحـوث الزراعيـة- الجيـزة -مصـر**
**** معهد بحوث تكنولوجيا الغذاء- مركز البحوث الزراعية – الجيزة -مصر**

أجريت تجربة حقلية بمحطة البحوث الزراعية بالاسماعيلية والتابعة لمركز البحوث الزراعية وذلك فى موسم ٢٠٠٢/ ٢٠٠٣ لتقييم استخدام كل من السيانوبكتريا ومحلول الميكروبات الفعالة كسماد حيوى يوفر جزء من السماد النيتروجينى اللازم لانتاج القمح وتأثير ذللك على محصول القمح من الحبوب والقش والمحتوى النيتروجينى والفوسفورى والبوتاسيومى لكل من الحبوب والقش ،الصفات التكنولوجية للحبوب، النيتروجين المتاح بالتربة بعد حصاد القمح و المحتوى الميكروبى بالتربة بعد الحصاد.
فى هذة التجربة تم تلقيح القمح بالسيانوبكتريا جافة بمعدل ١٥ كجم / للفدان وكذلك رش محلول الميكروبات الفعالة بمعدل ٤٠ لتر للفدان بحيث تم استخدام أى منهما منفردا أو مجتمعين تحت تأثير مستويات مختلفة من النيتروجين هى المستوى الموصى به و٢/ ١ المستوى الموصى به و ١/٤ المستوى الموصى به. وكانت

أ هم النتائج المتحصل عليها كما يلى:

أولا: مكونات محصول القمح (الحبوب والقش):

١- تحقق أعلى محصول للحبوب (١٢٩٥,٣٤ كجم/ فدان) عند استخدام السيانوبكتريا + الميكروبات الفعالة + المستوى النيتروجينى الكامل الا أن هذا المحصول كان غير مختلف معنويا مع ذلك المتحصل علية عند استخدام نفس المعاملة + ٢/ ١ المستوى النيتروجينى الكامل (١٢٧٤,٧٧ كجم/ فدان). مما يعنى امكانية توفير نصف كمية النيتروجين المعدنى المستخدمة فى التسميد مما يقلل من تكاليف الانتاج مع المحافظة على البيئة من التلوث نتيجة الافراط فى استخدام الأسمدة المعدنية.
٢- أعطى استخدام المستوى النيتروجينى الكامل منفردا أعلى محصول للحبوب بالمقارنة مع استخدام مستويات النيتروجين الأخرى منفردة.
٣- أظهر محصول القش نفس الاتجاه المتحقق مع محصول الحبوب.
٤- لم يكن هناك اتجاه محدد لتأثير المعاملات تحت الدراسة على وزن ال ١٠٠٠ حبة.

ثانيا : محتوى العنا صر (نيتروجين – فوسفور- بوتاسيوم) لكل من ا لحبوب والقش:

١- تحقق أعلى محتوى نيتروجينى للحبوب (٢٢,٠٣كجم نيتروجين/ فدان) عند استخدام السيانوبكتريا + الميكروبات الفعالة + المستوى النيتروجينى الكامل الا أن هذا المحتوى النيتروجينى كان غير مختلف معنويا مع ذلك المتحصل علية عند استخدام نفس المعاملة + ٢/ ١ المستوى النيتروجينى الكامل (٢١,٦٧ كجم نيتروجين / فدان).
٢- أظهر محتوى الحبوب من الفوسفور والبوتاسيوم نفس الاتجاه المتحقق مع المحتوى النيتروجينى.
٣- لقد أظهر محتوىالقش من النيتروجين والبوتاسيوم نفس الاتجاه المتحقق مع المحتوى النيتروجينى والبوتاسيوم للحبوب. وعلى العكس من ذلك محتوى القش من الفوسفور عند استخدام نفس المعاملة + ٢/ ١ المستوى النيتروجينى الكامل (٤,١٥ كجم فوسفور/ فدان) أعلى معنويا من ذلك المتحصل عليه عند استخدام نفس المعاملة + المستوى النيتروجينى الكامل (٢,٩٨ كجم فوسفور / فدان).

ثالثا : الصفات التكنولوجية للحبوب:

أدى استخدام أى من السيانوبكتريا أو الميكروبات الفعالة إلى تحسين الصفات التكنولوجية لحبوب القمح فيما عدا البروتين.

رابعا : العناصر المتاحة بالتربة بعد حصاد القمح:

أدى التلقيح بالسيانوبكتريا أو الرش بمحلول الميكروبات الفعالة الى زيادة كل من النيتروجين والفوسفور المتاح بالتربة بعد حصاد القمح بالمقارنة مع المعاملات الأخرى بينما تأرجح تركيز البوتاسيوم المتاح بالتربة بعد حصاد القمح بين الزيادة والنقصان نتيجة لأثر المعاملات تحت الدراسة.