J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 3 (2): 283 - 295, 2012

THE COMBINED EFFECT OF CYANOBACTERIA EXTRACT AND MICRONUTRIENTS SPRAYING ON WHEAT PRODUCTIVITY, NUTRIENTS CONTENT AND NITROGEN FERTILIZER OPTIMIZATION

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ABSTRACT

Two successive winter seasons of 2008/2009 and 2009/2010 wheat field experiments were carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt to study the effect of some micronutrients and cyanobactria spraying on wheat productivity and nitrogen fertilizer optimization. Split split plot design was used with four replicates. the main plots were assigned by two cynobacteria treatments, with and without cyanobacteria extract spraying. Nitrogen was added in the sub plots under two levels, (144 and 168 kg N ha^{-1}). The sub sub plots were assigned by four treatments of micronutrients spraying as follows ;-1- without micronutrients spraying (M_0) 2- micronutrients spraying as sulphate form of the used elements (M_1) 3- micronutrients chelaeted as EDTA (M_2), and 4- micronutrients cheleated as amino acids (M_3) . (The same concentration was used with the all).

Results revealed that, the treatment of 168 kg N ha^{-1}, cyanobacteria and micronutrients spraying increased the grain yield compared with the other treatments. The highest grain yields (5.8 and 5.98 ton ha^{-1}) were obtained with the interaction between168 kg N ha^{-1}, cyanobacteria extract spraying and micronutrients chelated on amino acid treatment. The biological yield (14.94 and 14.57 ton ha^{-1}) were significantly increased due to the addition of 168 kg N ha^{-1} followed by 13.62 and 13.18 ton ha^{-1} with 144 kg N ha^{-1} in the first and second seasons, respectively. The highest grain N content values (93.88, 101.5 and 93.29, 102.33 kg N ha^{-1}) were obtained with M_3 with and without cyanobacteria in the first and second season, respectively. The highest mean values of P content in the grain (12.57 and 13.27 kg .ha^{-1}) were obtained with N level of 168 kg N ha^{-1} compared with 12.59 and 11.95 kg P ha^{-1} with 144 kg N ha^{-1}. Spraying micronutrients high significantly affected available N and P in the soil. The highest available N values were observed in both seasons with N_2, M_3 and C_0 treatments. The mean value of NUE was decreased by increasing of N level. The micronutrients affected NUE in both N level and cynobacteria treatments as the order: $M_3 > M_2 > M_1 > M_0$.

Keywords; Micronutrients, cyanobactria, amino acid, N P content, nitrogen fertilizer and wheat yield

INTRODUCTION

The deficiency of micronutrients (Zn, Mn, Fe and Cu) in soils of arid and semi arid regions forms one of the major yield limiting factors and can greatly disturb plant yield and quality. In most of the cultivated areas in Egypt, deficits of micronutrients showed a pattern of Zn = Mn > Fe > Cu (El- Fouly, 1983; Amberger, 1991 and Malakouti, 2008). Under such conditions, soil application of micronutrients can be very expensive and quickly fixed again. Macro and micro-nutrients added to the high pH soils, their availability will be affected by the soil environmental factors. Foliar feeding technique, as a particular way to supply these nutrients could avoid these factors and results in rapid absorption and less costly (El-Fouly and El- Sayed, 1997).

Nitrogen is often the most deficient of all the plant nutrients. It is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization. The most important role of N in the plant is its presences in the structure of protein, the most important building substances from which the living material or protoplasm of every cell is made. In addition, nitrogen is also found in chlorophyll, the green colouring matter of leaves. Chlorophyll enables the plant to transfer energy from sunlight by photosynthesis. Therefore, the nitrogen supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. In turn, this influences cell size and leaf area, and photosynthetic activity.

Using the nitrogen fixing cyanobacteria and using nitrogen fertilizer in organic and inorganic form in order to improve soil fertility and enhancing vegetative growth for increasing wheat productivity. The use of nitrogen fixing cyanobacteria ensures entirely or partially the mineral nitrogen. While effective microorganisms are 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, particularly cereals such wheat and N_2-fixing microorganisms including cyanobacteria (Spiller *et al*., 1993). The nitrogen fixed by Nostoc sp and the stimulating agent in association with wheat is taken up by the plant and supports its growth, improving grain yields and grain quality (Gantar *et al*., 1995). N fertilizer source and application technique influenced grain proteins and noodle quality (Ehdaie and Waines, 2001). In a field experiment, topdressing N fertilizer at 270–360 kg N/ha improved noodle texture (Ma *et al*., 2009). Morgounov *et al*. (2007), found a strong positive relationship between Fe, Zn, and protein content (r = 0.65; r = 0.68 respectively) of grain from 25 spring wheat varieties grown under field conditions. Other research also indicates a potentially positive effect of N fertilization on micronutrient density in wheat grain (Kimball *et al*. and Yue *et al*., 2007).

Therefore, the aim of this work is to evaluate the combined effect of cyanobacteria extract and micronutrient sources foliar spraying with two levels of nitrogen fertilization on wheat productivity, optimizing of nitrogen mineral fertilizer, nitrogen and phosphorus contents.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt, at Northern Delta region ($31^o05'$ N latitude and $30^o56'$ E longitude), during two successive winter seasons of 2008/2009 and 2009/2010 to study the effect of some micronutrients sources and cyanobacteria extract spraying on wheat (Triticum aestivum L. Sakha 93) productivity and nitrogen fertilizer optimization. Some physical and chemical properties according to (Page *et al*., 1982) of the experimental soil are shown in Table 1.

Table 1: Some physical and chemical properties of the experimental field soil

Season	Particle size distribution (%)			Texture class	EC dSm^{-1}	pH (1:2.5)	Organic Matter (%)	Available nutrients ($mg\ kg^{-1}$)		
	Sand	Silt	Clay					N	P	K
2009	12.3	33.3	54.4	Clayey	2.46	7.81	1.89	22	7	296
2010	16.2	30.2	53.6	Clayey	1.98	7.93	1.64	19	6.9	164

The experimental field was prepared and then divided into 64 plots (3m X 3.5 m each) to represent 16 treatments in four replicates arranged in statistical split split plot design. Cyanobacteria (the cyanobacterium Nostoc sp., was taken from Soils, Water & Environ. Res. Inst., ARC. Giza, Egypt, without (C_0) and with (C_1)cyanobacteria to represent the main plots two litter of mother culture extract diluted to 500 litter water and then sprayed ha^{-1}. While, nitrogen fertilizer represents the sub plots in two levels (144 and 168 kg N ha^{-1}). Four treatments of micronutrients represent the sub sub plot as follows:-1- without micronutrients spraying (M_0). 2- micronutrients spraying as sulphate formof the used elements (M_1) 3- micronutrients chelaeted as EDTA (M_2), and 4- micronutrients chelaeted as amino acids (M_3). Micronutrient compounds were prepared by Soil Fertility and Plant Nutration department, Sakha, Agric. Res. Stat., where each micronutrient source contain 2.5% Fe, 1 % Mn, 0.5% Zn and 0.1% Cu (2.4 L. ha^{-1}).

Uniform application of phosphate at the rate of 268 kg ha^{-1} as superphosphate (15.5 % P2O5) and potassium in the form of potassium sulfate (48% K2O) at the rate of 119 kg ha^{-1} were done as basal to each plot. Nitrogen as urea was applied in three split equal doses according to the treatment. Cyanobacteria extract was sprayed at the tillering stage, micronutrients were foliar sprayed five weeks after sowing at the rate of 2.4 L ha^{-1}. All recommended agriculture practice was carried out. The harvesting was done at May 5th and 7th 2009 and 2010 at maturity of plants, respectively, one meter square from each treatment was taken to evaluate the grain yield (ton ha^{-1}), straw yield (ton ha^{-1}); 100 grain weight (g), and the biological yield per ha) were recorded. Straw and grain samples of each treatment were oven dried at 70°C to become constant weight, finely ground and then kept for chemical analysis the samples were digested by using sulphoric – percholoric acids, according to Jackson (1967). The digested materials were distilled by micro-kjeldahl method, and total nitrogen in grain and straw were determined according to Page *et al.* (1982). as well as to determine the nitrogen use efficiency. Phosphorus (P%) in straw and grain were done colorimetrically by according to the method described by Snell and Snell (1976). Available N in soil was extracted by 2N KCl and determined by using semi micro kjeldahl technique and available P I the soil was extracted by sodium biocarbonate 0.5M at pH 8.5 according to Olsen method and measured photometrically color using ammonium molybedate and stannous chloride as a reducing agent according to Page *et al*. (1982). All obtained results in both seasons were statistically analyzed as mean values for both seasons which compared for the least significant difference (L. S. D.) as described by Gomez and Gomez

(1984). Nitrogen or phosphorus content was calculated by multiplying the nitrogen concentration by the dry matter (grain or straw) as follow:

$$\text{N or P content (kg)} = \frac{\text{N\% or P\% x plant dry matter yield}}{100}$$

Nitrogen use efficiency (NUE) was calculated as grain yield Kg /1 Kg N was added.

RESULTS AND DISCUSSION

Wheat grain yield and 100 grain weight

Data in Table 2 indicate the effect of micronutrients, cyanobacteria spraying and nitrogen fertilization levels on wheat grain yield and 100 grain weight Wheat grain yield was increased high significantly with increasing N fertilization level. The highest mean values of grain yield (5.42 and 5.50 ton ha^{-1}) attained by 168 kg N ha^{-1} in the first and second season, respectively followed by (4.55 and 4.74 ton ha^{-1}) for 144 kg N ha^{-1}. Insignificant increase of wheat grain was obtained with cynobacteria extract spraying. The highest mean values of wheat grain yield (4.99 and 5.20 ton ha^{-1}) were obtained with extract of cyanobacteria spraying in the first and second season, respectively, followed by (4.97 and 5.04 ton ha^{-1}) under without cyanobacteria treatment. However, there were significant differences between the four micronutrients sources treatments in the first season and high significantly in the second season, the highest mean values of grain yield were obtained with the treatments of micronutrients chelaeted on amino-acid in the both seasons. The combination between the nitrogen treatment and spraying cyanobacteria extract and micronutrients chelaeted on amino-acid increased the grain yield in two seasons compared with the other treatments, its were 5.80 and 5.98 ton ha^{-1} in the first and second season, respectively, but the differences were less than significant effect and highly significant in the second season.

100-grain weight showed an indefinite trend in response to the tested treatments. However, this notice depends on the number of panicles plant-1, which correlated drastically with the grain yield. The highest mean values 5.19 g was obtained with 168 kg N ha^{-1} in the first season. Generally, using cyanobacteria as a growth stimulating material decreased 100 grain weight with the 168 kg N fertilizer compared with the other treatment. The micronutrients treatments and the interaction between treatments were high significantly in the second season. These results are in agreement with those described by Abd -Alla *et al*. (1994) and Mussa *et al*. (2003).

Table 2: Effect of cyanobacteria, micronutrients spraying and nitrogen fertilization levels on wheat grain yield and 100 grain weight in 2009 and 2010 season.

Treatments	Micro-nutrient	Grain yield (ton ha^{-1})				100 grain weight ((g)			
		1st		2nd		1st		2nd	
		C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
N1 (144 kg N ha^{-1})	M_0	4.38	4.50	4.43	4.59	5.15	5.20	5.22	5.18
	M_1	4.53	4.60	4.62	4.68	5.25	5.06	5.20	5.12
	M_2	4.67	3.76	4.75	4.82	5.33	5.10	5.28	5.10
	M_3	4.94	4.98	4.95	5.10	5.09	5.01	5.15	5.06
	Means	4.63	4.46	4.69	4.80	5.21	5.09	5.21	5.11
Mean N1		4.55		4.74		5.15		5.16	
N2 (168 kg N ha^{-1})	M_0	5.13	5.28	5.23	5.36	5.30	5.08	5.25	5.15
	M_1	5.28	5.39	5.34	5.44	5.21	5.03	5.18	5.06
	M_2	5.34	5.63	5.40	5.66	5.11	5.22	5.10	5.12
	M_3	5.49	5.80	5.62	5.98	5.23	5.31	5.21	5.28
	Means	5.31	5.53	5.40	5.61	5.21	5.16	5.18	5.15
Means		4.97	4.99	5.04	5.20	5.21	5.13	5.20	5.13
Mean N2		5.42		5.50		5.19		5.17	
		F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05
Cyanobacteria A		N.S	---	N.S	---	N.S	---	N.S	---
Nitrogen B		**	---	**	---	N.S	---	N.S	---
Micronutrient C		*	0.49	**	0.25	N.S	---	**	0.04
ABC		N.S	---	**	0.31	N.S	---	**	0.08

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

Wheat straw yield and biological yield

Data in Table 3 show the combined effects of cyanobacteria, micronutrients spraying, and nitrogen fertilization levels on wheat straw and biological yields. Significantly effect was observed of the straw yield in the first season and high significantly in the second season. The highest straw yield (9.61 and 9.24 ton ha^{-1}) was obtained with the treatment of without cyanobacteria in the first and second seasons, respectively and followed by (9.44 and 8.90 ton ha^{-1}) with cyanobacteria extract spraying. With regard to the effect of N level treatment, straw yield was high significantly increased with increasing of N levels (9.53 and 9.07 ton ha^{-1}) with 168 kg N ha^{-1} followed by (8.95 and 8.57 ton ha^{-1}) with 144 kg N ha^{-1} in the first and second seasons, respectively. This may be due to increasing of nitrogen fertilization level led to increase the tillering and increased the plant height which lead to increase straw yield. High significantly differences between the micronutrient source treatments were observed in the two seasons, the treatment of micronutrients chelaeted on amino-acid done highest straw yield in both seasons. The interaction between the treatments was high significantly in the first season only, the highest mean values (9.95 and 9.60 ton ha^{-1}) were observed with 168 kg N ha^{-1}and micronutrients chelaeted as amino- acid.

Table 3: Effect of cyanobacteria extract, micronutrients spraying and nitrogen fertilization levels on wheat straw and biological yields (ton ha^{-1}) in 2009 and 2010 season.

Treatments	Micro-nutrient	Straw yield				Biological yield			
		1st		2nd		1st		2nd	
		C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
N1 (144 kg N ha^{-1})	M_0	9.40	8.30	9.00	8.22	13.78	12.80	12.43	12.81
	M_1	9.00	8.15	8.50	8.00	13.43	12.78	13.12	12.68
	M_2	9.27	9.20	8.70	8.30	13.97	14.02	13.44	13.12
	M_3	9.60	8.70	9.20	8.60	14.54	13.65	14.15	13.68
	Means	9.32	8.59	8.85	8.28	13.93	13.31	13.28	13.09
Mean N1		8.95		8.57		13.62		13.18	
N2 (168 kg N ha^{-1})	M_0	9.40	9.00	8.91	8.55	14.53	14.28	14.14	13.91
	M_1	9.40	9.85	9.10	8.80	14.68	15.24	14.44	14.24
	M_2	9.70	9.10	9.35	9.00	15.04	14.73	14.75	14.66
	M_3	9.95	9.80	9.60	9.23	15.41	15.60	15.22	15.22
	Means	9.61	9.44	9.24	8.90	14.92	14.96	14.64	14.50
Means		9.47	9.01	9.05	8.59	14.42	14.14	13.96	13.79
Mean N2		9.53		9.07		14.94		14.57	
		F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05
Cyanobacteria A		*	----	**	---	*	---	N.S	---
Nitrogen B		**	----	**	---	**	---	**	---
Micronutrient C		**	0.35	**	0.32	**	0.71	**	0.62
ABC		**	0.68	N.S	---	**	0.41	**	0.46

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

This may be due to micronutrients on amino- acid enhanced the growth hormones and enzymes which reflected on plant vegetative growth in presence of enough nitrogen to complete cells and tissues need. Also, data in Table 3 show that, the biological yield had the same behavior such as straw yield. The biological yield was significantly increased with increasing of N levels where it was 14.94 and 14.57 ton ha^{-1} with 168 kg N ha^{-1} treatment ,followed by 13.62 and 13.18 ton ha^{-1} with 144 kg Nha^{-1} level, in the first and second seasons, respectively. This may be due to straw yield one of the two component of the biological yield, increasing or decreasing straw yield affect the biological yield.

In respect to micronutrients treatments, M3 had the highest values in both seasons. Also, the interaction between the treatments was high significantly in both seasons ,the highest mean values (15.60 and 15.22 ton ha^{-1}) were obtained by spraying cyanobacteria extract,168kg N ha^{-1} and M3 treatments, in both seasons.

N and P content (kg ha^{-1}) in wheat grains:

Data in Table 4 revealed that the highest N content (90.43 kg ha^{-1}) was obtained with cyanobacteria compared to without cyanobactria treatment which gave 83.46 kg ha^{-1} in the second season only, but no significant differences between the treatments in the first season.

Table4: Effect of cyanobacteria; micronutrients spraying and nitrogen fertilization levels on N content and P content in wheat grain yield (kg ha^{-1}) in 2009 and 2010 season.

Treatments	Micro-nutrient	N content				P content			
		1st		2nd		1st		2nd	
		C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
N1 (144 kg N ha^{-1})	M_0	64.39	74.25	68.22	74.36	11.82	13.05	11.52	12.85
	M_1	69.76	72.22	70.22	76.75	11.85	11.50	11.09	12.17
	M_2	70.52	75.21	73.48	75.19	11.58	12.85	10.43	11.57
	M_3	79.86	80.68	81.68	85.68	11.45	12.95	11.39	11.22
	Means	71.13	75.59	73.40	78.00	11.68	12.59	11.11	11.95
Mean N1		73.36		75.70		12.13		11.53	
N2 (168 kg N ha^{-1})	M_0	79.52	85.54	80.54	86.30	13.85	12.73	14.12	15.01
	M_1	81.31	86.78	81.17	86.50	12.14	13.48	13.35	13.06
	M_2	84.91	86.80	78.84	86.60	11.75	12.39	12.42	12.45
	M3	93.88	101.5	93.29	102.33	10.98	11.60	12.36	12.56
	Means	84.90	90.16	83.46	90.43	12.17	12.57	13.06	13.27
Means		78.02	82.86	78.43	84.21	11.93	12.57	12.09	12.61
Mean N2		87.52		86.95		12.37		13.17	
		F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05
Cyanobacteria A		N.S	---	*	---	N.S	---	N.S	---
Nitrogen B		**	---	**	---	**	---	**	---
Micronutrient C		**	**0.76**	**	**1.63**	**	**0.22**	**	0.23
ABC		**	**1.52**	**	**3.27**	**	**0.50**	**	0.46

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

In respect to the effect of nitrogen levels on N content of wheat grain the differences were high significantly in both seasons. 168 kg N ha^{-1} had the highest N content in both seasons (87.52 and 86.95 kg N ha^{-1}) compared to (73.36 and 75.7 kg N ha^{-1}) with the first nitrogen level (144 kg N ha^{-1}).

This may be due to N2 level led to increase grain yield which increased N content. Micronutrients spraying high significantly affected nitrogen content in the grain in both seasons. The highest values (93.88, 101.5 and 93.29, 102.33 kg N ha^{-1}) were obtained with M3 with and without cyanobacteria in the first and second season, respectively. This may be due to M3 contain Fe, Mn and Cu chelaeted on amino acids which enhance plant absorption of the added micronutrients.

Phosphorus content of wheat grain kg ha^{-1} had the same sequence obtained with the nitrogen content. No significant effects of cyanobacteria on P content in the first season and significant effect in the second season. On the other hand high significantly effects were detected due to nitrogen levels and micronutrient sources. N2 had the highest P content (12.37 and 13.17 kg P ha^{-1}) in the first and second season, respectively.

N and P content (kg ha^{-1}) in wheat straw yield

Data in Table 5 indicate that N content values (46.15 and 43.55 kg N ha^{-1}) were recorded with the Cyanobacteria treatments in the first and second season, which it had significant effect in the first season. The N content in straw was increased with increasing of N levels were it was increased from

39.85 to 49.28 kg N ha^{-1} in the first season and from 38.46 to 46.49 kg N ha^{-1} in the second season.

In contrast, P content mean values were decreased with increasing N levels where it was (4.2 and 4.4 kg P ha^{-1}) with 144 kg N ha^{-1} compared with (3.87 and 4.28 kg P ha^{-1}) with 168 kg N ha^{-1}. Same effect with usage of cyanobacteria, P contents mean values were increased from (3.78 and 4.0 kg P ha^{-1}) without to (4.29 and 4.68 kg P ha^{-1}) with spraying cyanobactria extract in the first season. Data presented in Table 5 show that all micronutrients sources high significantly decreased phosphorus content in wheat straw in the two seasons. The decreases were rather clear under without cyanobacteria spraying treatment and under the high nitrogen level. Under cyanobacteria spraying P content was increased with the most micronutrients sources. This may be due to some micronutrients sources and cyanobacteria enhanced vegetative growth and straw yield which affected P content.

Increasing the nutrient concentration in wheat grain and straw in response to the use of cyanobacteria as a activator biofertilizer separately was confirmed by those of Abd EL- Rasoul *et al*. (2004) and Mussa *et al*. (2003) who indicated that spraying nitrogen fixing biofertilizers individually had significantly increased N P K concentration by grains and straw over the control treatments. This trend are in parallel to what revealed by EL- Mancy *et al*. (1997) who found that the use of biofertilizers reduced the amount of mineral nitrogen (about 50 %) and improved NPK uptake by rice grains and straw.

Table5: Effect of cyanobacteria, micronutrients spraying and nitrogen fertilization levels on N and P content in wheat straw yield (kg ha^{-1}) in 2009 and 2010 season.

Treatments	Micro-nutrient	N content				P content			
		1st		2nd		1st		2nd	
		C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
N1 (144 kg N ha^{-1})	M_0	37.60	34.86	36.90	37.81	4.51	4.98	4.50	4.74
	M_1	35.10	34.23	33.15	35.20	3.15	4.08	3.23	4.16
	M_2	39.06	40.48	35.67	37.35	3.26	4.32	3.74	5.15
	M_3	47.04	50.46	46.00	45.58	4.42	4.87	4.51	5.16
	Means	39.70	40.01	37.93	38.98	3.84	4.56	4.00	4.80
Mean N1		39.85		38.46		4.20		4.40	
N2 (168 kg N ha^{-1})	M_0	52.64	54.00	48.11	47.88	4.04	4.68	4.01	4.62
	M_1	47.94	50.23	45.17	47.52	3.29	3.25	3.46	4.05
	M_2	42.68	50.05	43.01	48.60	3.78	3.28	4.11	4.41
	M_3	41.79	54.88	43.20	48.46	3.78	4.90	4.42	5.17
	Means	46.26	52.29	44.87	48.11	3.72	4.03	4.00	4.56
Means		42.98	46.15	41.40	43.55	3.78	4.29	4.00	4.68
Mean N2		49.28		46.49		3.87		4.28	
		F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05
Cyanobacteria A		*	---	N.S	---	**	---	**	---
Nitrogen B		**	---	**	---	**	---	**	---
Micronutrient C		**	0.84	**	0.77	**	0.21	**	0.23
ABC		**	1.68	**	1.54	**	0.41	**	0.46

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

Soil available N and P

In respect to available N and P amounts remained in soil after wheat harvesting, results in Table 6 indicate that no significantly effects were detected for cynobacteria using except the first season of N. Nitrogen fertilization levels had high significantly effects on available N and P in the soil after wheat harvesting in both seasons. The highest mean values of available N 23.52 and 23.69 mg kg^{-1} were obtained with 168 kg N ha^{-1} followed by 20.87 and 21.5 mg kg^{-1} wit 144 kg N ha^{-1}. But available P was increased by increasing N level, which 23.37 and 24.4 mg kg^{-1} with the 168 kg N ha^{-1} followed by 20.02 and 19.96 mg.kg^{-1} with 144kg N ha^{-1}. Spraying micronutrients high significantly affected available N and P in the soil after wheat harvesting. The highest available N values of 27.13 and 27.13 in both seasons were observed with the interaction between N2, M3 and C_0 treatment. Also, the highest mean values of available P were obtained with the same treatment. This may be due to micronutrients and amino acids enhanced root distribution, which decomposed after wheat harvesting and N relised to the soil. In the contrary some investigator concluded that 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 (SBI) might help to regenerate quickly and improve soil structure. Albeit, cyanobacteria 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.

Table 6: Effect of cyanobacteria, micronutrients spraying and nitrogen fertilization levels on available N and P in soil after wheat harvesting (mg kg^{-1}) in 2009 and 2010 season.

Treatments	Micro-nutrient	Available N				Available P			
		1st		2nd		1st		2nd	
		C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
N1 (144 kg N ha^{-1})	M_0	23.46	20.13	21.88	21.00	16.48	18.08	16.40	17.20
	M_1	18.38	27.13	20.13	25.20	23.80	20.30	21.80	21.80
	M_2	17.33	18.38	18.38	19.86	17.20	16.40	18.08	16.48
	M_3	23.63	21.88	21.88	23.63	26.13	21.80	23.80	24.10
	Means	20.72	21.87	20.57	22.42	20.90	19.15	20.02	19.90
Mean N1		21.29		21.50		20.02		19.96	
N2 (168 kg N ha^{-1})	M_0	28.88	21.00	26.25	22.75	26.90	25.80	25.80	24.85
	M_1	26.25	21.88	25.20	21.88	17.90	20.60	18.50	21.80
	M_2	19.25	21.00	21.00	21.66	18.50	24.10	23.80	24.85
	M_3	27.13	22.75	27.13	23.63	24.85	28.30	25.80	26.90
	Means	25.38	21.66	24.90	22.48	22.04	24.70		
Means		23.04	21.77	22.73	22.45	21.47	21.92	21.75	22.25
Mean N2		23.52		23.69		23.37		24.04	
		F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05	F test	LSD 0.05
Cyanobacteria A		*	---	N.S	---	N.S	---	N.S	---
Nitrogen B		**	---	**	---	**	---	**	---
Micronutrient C		**	1.68	**	1.42	**	1.40	**	1.35
ABC		**	3.35	**	2.67	**	3.68	**	3.58

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

Nitrogen use efficiency (kg grain per kg N fertilizer)

Data in Table 7 indicate that, there is no effect of using cyanobaceria on NUE in the first season, while this effect was significant in the second season, where, using cynobacteria increased NUE in the second season. But, the mean values of NUE were significantliy decreased by increasing N level. They were 32.19 and 32.80 with 168 kg N followed by 32.43 and 32.95 with 144 kg N in the first and second seasons, respectively.

The interaction between cynobacteria, N and micronutrients increased NUE in both seasons. The highest mean values (34.58 and 35.62 kg) were recorded with 144 kg N ha^{-1}, C_1 and M3 treatment in the first and second seasons, followed by (32.89 and 33.39 kg) with 168 kg N ha^{-1}, C_1 and M3.

Table7: Effect of cyanobacteria, micronutrients spraying and nitrogen fertilization levels on nitrogen use efficiency (NUE) (kg grain / kg N fertilizer) in 2009 and 2010 season.

Micronutrients	NUE (grain)							
	1st				2nd			
	N_1		N_2		N_1		N_2	
	C_0	C_1	C_0	C_1	C_0	C_1	C_0	C_1
M_0	30.52	31.25	30.05	31.43	30.76	31.88	31.43	31.90
M_1	31.39	31.94	31.43	32.08	32.08	32.50	31.79	32.38
M_2	32.43	33.06	31.79	33.51	32.91	33.47	32.14	33.69
M_3	34.31	34.58	32.68	34.52	34.38	35.62	33.45	35.60
Means	32.16	32.71	31.49	32.89	32.53	33.37	32.20	33.39
Mean N1	32.43		32.19		32.95		32.80	
	F test		LSD 0.05		F test		LSD 0.05	
Cyanobacteria A	N.S		---		*		---	
Nitrogen B	*		---		N.S		---	
Micronutrient C	**		0.27		**		0.52	
ABC	**		0.53		N.S		---	

M_0= control M_1=Cu+Zn+fe M_2= Cu+Zn+fe+EDTA M_3= Cu+Zn+fe+amino acid
C_0= without cyanobacteria C_1 = with cyanobacteria

The lowest mean valu (30.05 kg) was observed of NUE by C_0 and M0 with 168 kg N ha^{-1}, followed by (30.52) with 144 kg N ha^{-1}, C_0 and M_0. The micronutrients affected NUE in both N level and cynobacteria treatments as the order: $M_3 > M_2 > M_1 > M_0$.

This may be due to cynobacteria and amino acid enhanced the assimilation in plant and regulate the growth, this led to increasing the nutrients absorption to produce healthy plant and high productivity.

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التأثير المشترك للرش بمستخلص السيانوبكتريا و العناصر الصغرى على انتاجية القمح ومحتوى العناصر وترشيد السماد النتروجينى

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نفذت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا خلال الموسمين الشتويين 2009/2008م ، 2010/2009م لدراسة تأثيرالرش ببعض العناصر الصغرى والسيانوبكتريا تحت مستويين من التسميد النتروجينى على انتاجية القمح ورفع كفاءة السماد النتروجينى . تم زراعة صنف قمح سخا 93 فى الموسمين . واستخدم تصميم القطع المنشقة المنشقة فى أربعة مكررات. شغلت القطع الرئيسية الرش بالسيانوبكتريا فى معاملتين أ- بدون رش ب – الرش بمستخلص السيانوبكتريا . وشغلت القطع المنشقة النيتروجين حيث أضيف على مستويين (144 و168 كجم ن / هكتار) . وشغلت القطع المنشقة المنشقة الرش بالعناصر الصغرى فى 4 معاملات:

1- بدون رش
2- الرش بالعناصر الصغرى فى صورة كبريتات من العناصر المستخدمة
3- الرش بالعناصر الصغرى المخلبة على اديتا (إيثيلين داي أمين تترا أستيك أسيد)
4- الرش بالعناصر الصغرى المخلبة علىأحماض أمينية

أستخدمت نفس التركيزات من العناصر المستخدمة فى كل المعاملات .

وقد أظهرت النتائج أن معاملة النتروجين 168 كجم ن / هكتار مع الرش بالسيانوبكتريا و العناصر الصغرى أدتلزيادة محصول الحبوب مقارنة بالمعاملات الأخرى . كان أعلى محصول حبوب (5.8 & 5.98 طن / هكتار)مع معاملة التفاعل بين 168 كجم ن / هكتار مع الرش بالسيانوبكتريا و الرش بالعناصر الصغرى المخلبة على أحماض أمينية فى الموسم الأول والثانى, على التوالى.ازداد معنويا المحصول الحيوى بزيادة مستوى النتروجين حيث كان14.94 & 14.57 طن / هكتار مع المستوى 168 كجم ن / هكتار فى الموسمين وجاء بعده 13.62 &13.18 طن / هكتار مع المستوى 144كجم ن / هكتار فى الموسمين الأول و الثانى ،على التوالى . كانت أعلى قيم محتوى النتروجين فى الحبوب (102.33، 93.29 & 105 ، 93.88 كجم ن / هكتار) و تم الحصول عليها مع المعاملة M_3 مع او بدون السيانوبكتريا فى الموسم الأول

والثانى، على التوالى. وكانت أعلى قيم محتوى الفوسفور فى الحبوب 12.53 &13.17 كجم فو /هكتار وقد تم الحصول عليها مع المستوى 168 كجم ن /هكتار مقارنة بالقيم 12.59 & 11.95 كجم فو /هكتار مع المعاملة 144 كجم ن / هكتار. أثر رش العناصر الصغرى على النيتروجين و الفوسفور الميسر فى الأرض تاثيرا عالى المعنوية .وكانت اعلى قيم النيتروجين الميسر فى الموسمين مع المستوى ألأعلى من النيتروجين ورش العناصر المخلبة على الحامض الأمينى وبدون رش السيانوبكتريا. انخفضت قيم كفاءة استخدام النيتروجين بزيادة مستوى النيتروجين المضاف. أثرت العناصر الصغرى على كفاءة استخدام النيتروجين كالترتيب التالى: العناصر الصغرى المحملة على حمض أمينى > المحملة على اديتا > الموجودة فى صورة كبريتات.

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