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RESPONSE OF WHEAT TO BIOFERTILIZER INOCULATION UNDER DIFFERENT SOURCES AND LEVELS OF NITROGEN

Asmaa A.Sh. Khalil*, A.A. Shiha, S.M.M. Dahdouh and A.M. Helmy

Soil Sci. Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

A pot experiment was conducted at experimental farm (Abo Al-Akhdar clay soil), Faculty of Agriculture, Zagazig University to study the effect of organic and mineral nitrogen at rates of 50, 75 and 100 mg N kg^{-1} and seed bioinoculation using *Azotobacter chroococcum* N-fixing bacteria as a fertilizer called Cerealine, and a mixture *Azotobacter chroococcum* and *Azospirillium lepoferm* N-fixers + *Bacillus megatherium* P-dissolving bacteria as a fertilizer called Nitrobien. The interaction effects between biofertilization, organic and chemical fertilizer sources and levels on wheat yield, chemical composition and uptake of nitrogen, phosphorus and potassium were studied. Results reveal that high of wheat straw yield and straw nitrogen uptake can be obtained with treatment of 100 mg N kg^{-1} of chicken manure with inoculation by Nitrobien. The highest straw phosphorus and potassium uptake obtained under application 75 mg N kg^{-1} of chicken manure and inoculation by Nitrobien. The highest straw phosphorus and potassium uptake were obtained under application 75 mg N kg^{-1} of chicken manure and inoculation by Nitrobien. The highest phosphorus uptake by grain were obtained under application 75 mg N kg^{-1} of ammonium sulphate without inoculation, while the highest potassium uptake by grain obtained under application of 50 mg N kg^{-1} of chicken manure without inoculation.

Keywords: Wheat, Biofertilizer, Cerealine, Nitrobien, Organic fertilizers

* **Corresponding author:** Asmaa A.Sh. Khalil, **Tel.:** +20122396323
E-mail address: llasmaa @yahoo.com

INTRODUCTION

Biofertilizers are preparations containing live or latent cells of efficient strains of microorganisms used for application to seeds, soil, or composts to increase availability of plant nutrients. They include organic sources (manures) for plant growth, Subba Rao (1982). Sharief *et al.*, (1998) found that inoculation of wheat grains with a mixture of Azospirillium and Azotobacter bacteria in a form of biofertilizer called (Cerealine) increased wheat weight, number of grains / spike, 1000-grain weight and grain and straw yields. Abd El-Rasoul *et al.*, (2003) investigated sources of fertilizers and inoculation with the biofertilizer Cerealine and found a significant effect on yield of wheat and its components. Amara and Dahdoh (1997) stated that inoculation with Cerealine increased the uptake of N, P and K in straw of wheat. Fouda (2007) showed that inoculated wheat seeds with Cerealine significantly increased phosphorus and potassium content in grains. El-Maddah *et al.*, (2005) indicated that nitrogen content and uptake were significantly increased in wheat plants inoculated with *Azotobacter chroococcum* combined with mineral nitrogen fertilizer. Meshref *et al.*, (2000) reported that significant decreases in leached NO_3^- and NH_4^+ in drainage water were recorded due to biofertilizers and organic manure application. Their results illustrate the beneficial effect of bio and organic fertilization on reducing the adverse impacts of inorganic nitrogen in agro-ecosystem. The current study aims at (1) assessing the effects of seed inoculation using Cerealine (free living N_2-fixing bacteria) and Nitrobine; 2) how to minimizing the levels of N to obtain maximum yield under different levels of inoculation. 3) evaluating the interaction effects between different microbial inoculation, organic and chemical fertilizer sources and levels on wheat yield, chemical composition and uptake of nitrogen, phosphorus and potassium.

MATERIALS AND METHODS

Pot experiments was carried out under greenhouse conditions at the Faculty of Agriculture of Zagazig University, during winter season of 2006-2007 in order to study the effect of inoculation with biofertilizers in presence of different nitrogen sources and rates

on growth, yields and chemical composition of wheat *Triticum aestivum* c.v. Sakha 69 grown on clay soil from Faculty of Agriculture farm (Abo Al-Akhdar area), Sharkia Governorate.

The design of the experiment was a randomized complete block, factorial, involving 3 factors and executed in 3 replicates. Factors of experiment were as follows:

Factor A: Nitrogen sources; ammonium sulphate, chicken manure and town refuse.

Factor B: Nitrogen rate; 3 rates 50, 75 and 100 mg N kg^{-1}.

Factor C: Biofertilization: none, without addition, N-fixing bacteria Azos + Azot and N-fixing + P-dissolving bacteria.

There was also a treatment of no N addition for each of the biofertilization treatments.

The following biofertilizers and micro-organisms included in them:

1- The N-fixing bacteria are macula of *Azospirillium lepoferm* and *Azotobacter chrocuccum* (N-fixing bacteria) supplied as a commercial fertilizer called Cerealine.

2- The N-fixing + P-dissolving bacteria are containing *Azospirillium lepoferm* and *Azotobacter chrocuccum* (N-fixing bacteria) + *Bacillus megatherium* (P-dissolving bacteria) supplied as a commercial fertilizer called Nitrobien.

Thus the total number of treatment combinations was 27 (3 nitrogen sources × 3 nitrogen rates × 3 biofertilizers addition).

Nitrogen was in the form ammonium sulphate (20.5 % N) was applied in two equal halves; one half was applied before the first irrigation, while the remaining half was applied before the second irrigation. The organic source was applied in one dose at soil preparation.

Soil samples were taken, air dried and ground to pass through a 2 mm sieve, soluble cations and anions, pH and organic matter, calcium carbonate, electric conductivity, available N, P and K were determined as follows :

The international pipette method was used to determine the particle size distribution as described by Piper (1950); the chemical analysis of soil samples were carried out according to Jackson (1967); pH by pH-meter, EC (in saturated

extract) by EC-bridge, organic matter by Walkley and Black (Hesse, 1971), calcium carbonate by calciumeter. Available nitrogen in the soil was extracted by 2.0 M KCl according to (Hesse, 1971), and determined by macro-kjeldahl apparatus. Available phosphorus in the soil was extracted by 0.5 M $NaHCO_3$ (pH 8.5) and determined by spectrophotometer. Available potassium was extracted by 1.0 N ammonium acetate (pH 7) and determined by flamephotometer (Hesse, 1971).

Data of some physical and chemical properties are shown in Table 1.

Samples of wheat plants were taken at tillering, booting and harvest stages. In every stage, 5 plants were taken at random from each pot and dried at 70 °C till constant weight, and expressed as g 5 plant^{-1}. Grain and straw yields weight were determined.

Analysis for concentration of each N, P and K was determined in digests of plant material using concentrated acid mixture of sulphuric / perchloric acids (4:1). Nitrogen was determined by the Kjeldahl method (Chapman and Pratt, 1961 and Peterburgski, 1968). Phosphorus content was determinate calorimetrically using ascorbic acid method (Watanabe and Olsen, 1965). Potassium was determinate by the flame photometer according to Jackson (1967).

Table 1. Physical and chemical properties of the studied soil

Particle size distribution and organic matter (O.M)		Chemical properties			Available macronutrients (mg kg^{-1})	
		EC (dSm^{-1})		2.67		
Clay %	52.81	pH		7.82	N	53
			Na^+	14.7		
Silt %	12.97	Soluble	K^+	0. 7		
		cations	Ca^{++}	5.4	P	8.42
Fine sand %	27.10	mmolc L^{-1}	Mg^{++}	6.6		
			Cl^-	7.9		
Course sand %	7.12		$CO_3^=$	0		
		Soluble	HCO_3^-	3.0	K	188.21
		anions				
Texture class	Clay	mmolc L^{-1}	$SO_4^=$	16.9		
O. M. %	0.51	SAR		6.08		

EC of 1 :2.5 extract and pH in 1 : 2.5 suspension.

Table 2. Some properties of the used organic manure

Organic manures	EC (dS m^{-1})	pH	OC (g kg^{-1})	C/N Ratio	Total N %	Total P %	Total K %
Chicken manure	4.80	6.75	37	4.32	2.4	1.6	1.5
Town refuse	8.93	6.75	15.79	14.22	1.2	0.6	0.9

EC of 1 :2.5 extract and pH in 1 : 2.5 suspension

RESULTS AND DISCUSSION

Dry Matter Yield

Table 3 shows that dry matter yield of wheat plants which received with or without biofertilizers were ranged between 1.0 and 2.19 g / 5 plants at tillering stage. The lowest value was obtained under the application rate 100 mg N kg^{-1} of ammonium sulphate with Cerealine, while the highest value of dry matter yield was observed at level 75 mg N kg^{-1} as chicken manure without addition biofertilizer.

Regarding the general trend of biofertilizer addition, the data show that without using biofertilizers addition of N ChM or town refuse (TR) or ammonium sulphate (AS) gave values higher in absence of biofertilizers.

About the effect of N rates, the data show that the dry matter of wheat plants at tillering stage was increased by 15.9, 12.4 and 25.4% by increasing N rate from 50 to 75 mg N kg^{-1} of AS, ChM and TR respectively, Increasing N rate from 75 to 100 mg N kg^{-1} decreased the dry matter yield of wheat plants at tillering stage by 17.5, 14.6 and 4.2% with using AS, ChM and TR respectively.

Dry matter of wheat at booting stage ranged between 5.11 and 7.89 g 5 $plants^{-1}$. The lowest value was obtained under the application of chicken manure at mg N kg^{-1} with addition of Cerealine, while the highest value was obtained with application of ammonium sulphate at rate 100 mg N kg^{-1} with addition Nitrobien.

Regarding the effect of N rates, the data show that increasing N

Table 3. Dry matter yield of wheat as affected by sources and rates of nitrogen as well as biofertilizer addition (g 5 Plants^{-1}) at different stages

N-Source (A)	N-Rate (mg N kg^{-1}) (B)	Tillering Stage			Booting Stage			Harvesting Stage					
								Straw			Grain		
		Without bio-add. * (C)	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.	
			Cer. **	Nit. ***		Cer.	Nit.		Cer.	Nit.		Cer.	Nit.
A.S	50	1.24	1.63	1.27	5.07	5.20	5.53	9.16	8.70	8.97	5.93	6.04	6.19
	75	2.06	1.26	1.48	7.16	5.41	7.79	7.31	9.37	9.56	4.21	7.35	7.16
	100	1.58	1.00	1.38	5.25	6.29	7.89	8.99	8.34	12.12	6.96	5.64	8.20
Ch.M	50	1.53	1.59	1.68	6.77	4.96	5.85	12.21	9.98	9.12	8.55	8.03	7.66
	75	2.19	1.64	1.90	6.26	5.11	5.26	8.66	10.18	10.16	6.16	8.20	8.06
	100	1.90	1.50	1.51	5.60	5.98	7.47	10.36	9.80	11.79	8.19	7.56	9.45
T.R	50	1.62	1.20	1.21	5.34	6.09	6.59	10.21	9.84	9.01	7.38	6.95	7.09
	75	1.91	1.51	1.61	6.89	5.77	5.87	10.85	10.68	10.69	7.50	7.93	8.87
	100	1.46	1.56	1.81	6.40	5.99	5.99	10.09	10.95	10.87	8.37	8.20	8.65
No N addition		0.59	0.44	0.84	3.34	2.82	3.57	4.01	4.63	5.38	3.37	3.59	3.80

* Bio-add : Bio addition ** Cer : Cerealine *** Nit : Nitrobien

LSD :							
	A	0.10	N.S	0.32	0.28		
	B	0.12	0.39	0.37	0.32		
	AB	N.S	0.68	0.64	0.56		
	C	0.10	0.34	0.32	0.28		
	AC	N.S	0.59	N.S	0.48		
	BC	0.21	N.S	0.64	0.56		
	ABC	0.36	1.18	1.11	0.96		

rate from 50 to 75 mg N kg^{-1} increased the dry matter of wheat plants at booting stage by 28.8, and 2.3 % with using AS and TR respectively, but decreased it by 5.5 % using ChM. Increasing N rate from 75 to 100 mg N kg^{-1} decreased dry matter of wheat plants at booting stage by 6.4 and 1.0 % using AS and TR respectively, but increased by 14.6 % under using ChM. Regarding the main effect of biofertilization, the data show that using Nitrobien greater than using Cerealine under application AS, ChM and TR.

Under application AS and ChM without biofertilization gave greater dry matter than Cerealine.

Straw yield

Straw yield at harvesting stage was recorded and tabulated in Table 3. Dry matter of straw at maturity stage ranged between 8.66 and 12.12 g 5 $plants^{-1}$. The lowest value was obtained under application of ChM without application of biofertilization, while the highest value was obtained under the rate 100 mg N kg^{-1} of ammonium sulphate with using Nitrobien biofertilization.

Regarding the effect of addition of biofertilization, data show that application of Nitrobien gave greater yield than Cerealine. Regarding the main effect of N rate results show that application of rate 100 mg N kg^{-1} gave greater yield than either rate 50 or 75 mg N kg^{-1}, Application of TR higher than either AS or ChM. Data of inoculation are in agreement with those obtained by El-Zeky (2005) and Mekail *et al.* (2005).

Grain yield

Grain yield of wheat was ranged between 4.21 and 9.45 g 5 $plants^{-1}$. The lowest value was obtained under application of AS at rate 75 mg N kg^{-1} without application of biofertilization, while the highest value was obtained under the rate mg N kg^{-1} of ChM with application of Nitrobien.

Regarding the effect of N rate on grain yield, under application rate 100 mg N kg^{-1} of AS grain yield increased by 14.5 and 11.1 % compared with 50 and 75 mg N kg^{-1} respectively. Application rate 100 mg N kg^{-1} increased grain yield by 17.8 and 3.8 % greater than rate 50 and 75 mg N kg^{-1} respectively.

Regarding the effect of using biofertilization the data show that using Nitrobien gave grain yield greater by 34.7 % than using Cerealine biofertilization, and using Cerealine under as

application by 10 % and 5.8 % under ChM. Data of inoculation are in agreement with those obtained by El-Maddah *et al.* (2005) and Nour-El-Dein and Samia A. Salama (2006).

Nitrogen Uptake

Results of nitrogen uptake by wheat plants can be discussed under subheadings as follows:

a- Tellering Stage

Nitrogen uptake Table 4 of wheat plant at tillering stage was ranged between 5.8 and 12.98 mg N 5 plants^{-1}. The lowest value was obtained under application rate 100 mg N kg^{-1} of AS with using Cerealine, while the greater value of nitrogen uptake was obtained under application rate 75 mg N kg^{-1} with using biofertilization.

Regarding the effect of using biofertilizers at tillering stage on nitrogen uptake, the data show that without using biofertilization gave greater uptake than using either Cerealine or Nitrobien under application of AS or Ch.M, but under application TR using Microbien gave nitrogen uptake greater than Cerealine and without using biofertilization.

Regarding the effect of N rates, using 75 mg N kg^{-1} of AS gave nitrogen uptake greater than the rate 50 and 100 mg N kg^{-1} respectively. Using the rate 75 mg N kg^{-1} of ChM increased the nitrogen uptake in tillering stage by 16.3 and 27.8 % than rates 50 and 100 mg N kg^{-1} respectively.

b- Booting stage

Nitrogen uptake at booting stage was ranged between 75.14 and 208.5 mg N 5 plants^{-1}. The lowest value was obtained under application rate 75 mg N kg^{-1} of ChM using Cerealine, while the greater amount of nitrogen uptake in wheat plant at booting stage was obtained under using rate 75 mg N kg^{-1} as AS without biofertilizers addition.

Regarding the effect of N rates, under application 100 mg N kg^{-1} of AS, the nitrogen uptake increased by 33.4 and 13.5 % using rates 50 and 75 mg N kg^{-1} respectively. Using ChM at 100 mg N kg^{-1} gave increases of 27 and 14.5 % than using rate 50 and 75 mg N kg^{-1} respectively. Using rate 50 mg N kg^{-1} of TR gave 18.4 and 22.8 % greater uptake than using rates 75 and 100 mg N kg^{-1} respectively.

Regarding the effect of using biofertilizers, Nitrobien gave nitrogen uptake more than using Cerealine.

Table 4. Nitrogen uptake of wheat (mg/5 plants) as affected by sources and rates of nitrogen as well as biofertilizer addition sources at different stages

N-Source (A)	N-Rate (mg N kg^{-1})	Tillering Stage			Booting Stage			Harvesting Stage					
								Straw			Grain		
		Without bio-add. * (C)	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.	
			Cer. **	Nit. ***		Cer.	Nit.		Cer.	Nit.		Cer.	Nit.
A.S	50	6.82	11.08	9.40	120.67	126.36	125.53	38.47	53.07	58.31	104.37	134.09	123.18
	75	12.98	8.06	9.03	160.38	128.76	148.79	40.94	65.59	66.92	69.04	158.03	143.92
	100	10.43	5.80	8.97	139.65	158.51	198.83	50.34	65.89	112.72	151.03	121.26	187.78
Ch.M	50	10.56	8.90	9.74	108.52	78.86	119.93	51.28	56.89	63.84	185.54	138.92	160.86
	75	12.48	9.51	11.97	148.99	76.14	95.73	60.62	66.17	71.12	142.30	163.18	167.65
	100	10.64	8.25	7.70	109.76	108.84	139.69	43.51	59.78	71.92	206.39	151.96	211.68
T.R	50	8.59	7.20	8.35	104.66	130.94	138.39	57.18	55.10	45.95	134.32	126.49	158.82
	75	8.98	9.21	12.40	106.80	102.13	106.83	91.14	80.10	74.83	124.50	191.11	190.71
	100	8.03	9.20	12.31	107.52	93.44	103.63	70.63	55.85	70.66	148.15	170.56	155.70
No N addition		2.89	2.64	5.38	70.14	39.48	46.77	11.23	25.93	39.81	54.26	89.03	71.82

* Bio-add : Bio addition ** Cer : Cerealine *** Nit : Nitrobien

LSD :						
	A	N.S	9.69	9.16	N.S	
	B	N.S	11.19	10.58	7.41	
	AB	N.S	19.38	18.32	12.83	
	C	N.S	9.69	9.16	6.42	
	AC	N.S	16.78	15.87	11.11	
	BC	N.S	19.38	19.32	12.83	
	ABC	N.S	33.57	31.73	N.S	

c- Harvesting stage

Results presented in Table 4 Nitrogen uptake of straw yield was ranged between 38.47 and 112.7 mg N 5 plants^{-1}. The lowest value was obtained under application rate 50 mg N kg^{-1} of AS without addition of biofertilizers, while the highest value was obtained under using rate 100 mg N kg^{-1} of AS with using Nitrobien.

Using biofertilizer Nitrobien under application of AS gave 28.9 and 38.4 % greater uptake than using Cerealine and without biofertilization respectively. Under application of Ch.M, Nitrobien gave 13.14 and 33.1 % greater uptake than using Cerealine and without using biofertilizers, respectively. Under application TR, nitrogen uptake of straw yield was the same under using both of Cerealine and Nitrobien, and the value was lower by 14.69 % than without using biofertilizers. Data of inoculation are in agreement with those obtained by El-Ganaini *et al.* (2008) and Ibrahim *et al.* (2008).

Nitrogen uptake of grain yield ranged between 69.04 and 221.68 mg N 5 plants^{-1}. The lowest value was obtained under application rate 75 mg N kg^{-1} of AS without using biofertilizers, while the highest value was obtained under using rate 100 mg N kg^{-1} of ChM with using Nitrobien.

Using Nitrobien biofertilizers, under application AS gave more nitrogen uptake by grain greater than using Cerealine and without addition of biofertilization by 10 and 40.2 % respectively. Under application of ChM the data show that using Nitrobien gave greater uptake than Cerealine and without biofertilization by 19 and 1.2 % respectively. Under application of TR nitrogen uptake under using Nitrobien gave greater uptake than using Cerealine and without biofertilization by 3.5 and 24.1 % respectively. Data of inoculation are in agreement with those obtained by El-Maddah *et al.* (2005) and Mekail *et al.* (2005).

Phosphorus Uptake

The data of Table 5 shows phosphorus uptake (mg P_2O_5 5 plants^{-1}) of wheat plants at tillering, booting and harvesting stage and can be discussed under subheading as follows :

a- Tillering stage

Phosphorus uptake ranged between 2 and 5.56 mg P_2O_5 5 plants^{-1}. The lowest value was obtained under application rate 100 mg N kg^{-1} of AS and using

Table 5. Phosphorus uptake of wheat (mg/5 plants) as affected by sources and rates of nitrogen as well as biofertilizer addition sources at different stages

N-Source (A)	N-Rate (mg N kg^{-1}) (B)	Tillering Stage			Booting Stage			Harvesting Stage					
								Straw			Grain		
		Without bio-add. * (C)	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.		Without bio-add.	With bio-add.	
			Cer. **	Nit. ***		Cer.	Nit.		Cer.	Nit.		Cer.	Nit.
A.S	50	2.85	2.61	2.16	6.08	14.04	12.17	8.24	12.18	12.56	20.16	15.70	9.90
	75	5.56	2.14	2.81	11.46	16.23	7.79	4.39	7.50	7.65	10.10	16.17	19.33
	100	3.16	2.00	3.17	7.88	11.95	11.05	9.89	5.84	7.27	18.79	14.10	18.04
Ch.M	50	4.74	3.82	3.70	17.60	5.46	8.19	9.77	14.97	14.59	17.10	12.05	9.96
	75	5.26	3.44	4.56	10.64	3.58	7.36	5.20	12.22	17.27	17.25	9.84	7.25
	100	5.32	3.45	4.23	11.20	7.18	7.47	9.32	15.68	15.33	11.47	4.54	6.62
T.R	50	2.75	2.64	2.54	8.54	3.05	5.93	3.06	9.84	8.11	23.62	9.04	7.80
	75	2.67	3.62	3.70	12.40	5.77	4.70	7.60	8.54	8.55	10.50	9.52	11.53
	100	2.92	3.12	4.89	5.76	5.99	5.39	9.08	9.86	11.96	18.41	10.66	12.98
No N addition		1.30	0.79	1.68	2.67	5.36	6.43	2.41	3.70	3.23	8.43	8.98	7.60

* Bio-add : Bio addition ** Cer : Cerealine *** Nit : Nitrobien

LSD :							
	A	0.40	1.30	1.15	1.37		
	B	0.46	1.51	1.33	1.58		
	AB	0.79	2.61	2.30	2.73		
	C	0.40	N.S	1.15	1.37		
	AC	0.69	2.26	1.99	2.73		
	BC	0.79	2.61	2.30	N.S		
	ABC	N.S	4.52	3.98	4.74		

Cerealine, The highest value of phosphorus uptake was obtained under application 75 mg N kg^{-1} without biofertilization.

The rate 75 mg N kg^{-1} of AS and ChM gave phosphorus uptake greater than rates 50 and 100 mg N kg^{-1} under application AS and ChM, but the rate 100 mg N kg^{-1} of TR gave phosphorus uptake greater than 50 and 75 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that without addition biofertilizers under application of AS and ChM caused greater uptake than addition Cerealine or Nitrobien.

b- Booting stage

Phosphorus uptake ranged between 3.05 and 16.23 mg P_2O_5 5 $plants^{-1}$. The lowest value was obtained under application rate 50 mg N kg^{-1} of TR and addition of Cerealine, while the highest value of phosphorus uptake was obtained under application of 75 mg N kg^{-1} of AS and addition of Cerealine.

Regarding the effect of nitrogen rate, data show that 75 mg N kg^{-1} of AS and TR gave phosphorus uptake greater than rates 50 and 100 mg N kg^{-1}, but the rate 50 mg N kg^{-1} of ChM gave phosphorus uptake greater than 75 and 100 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that application of AS with Cerealine gave phosphorus uptake greater than AS with Nitrobien and without addition of biofertilization, while under application of ChM and TR without biofertilization gave phosphorus uptake greater than ChM and TR with addition of Cerealine or Nitrobien.

c- Harvesting stage

Phosphorus uptake was ranged between 3.06 and 17.27 mg P_2O_5 5 $plants^{-1}$. The lowest value was obtained under application rate 50 mg N kg^{-1} of TR and addition of biofertilization, while the highest value of phosphorus uptake was obtained under application rate 75 mg N kg^{-1} of ChM with Nitrobien.

Regarding the effect of nitrogen rate, data show that 50 mg N kg^{-1} of AS and TR gave phosphorus uptake greater than given by rates 75 and 100 mg N kg^{-1}, but under 100 mg N kg^{-1} of ChM or TR phosphorus uptake was greater than by application of 50 and 75 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that addition of Nitrobien gave phosphorus uptake greater than addition of Cerealine. Data of inoculation are in agreement with

those obtained by Nour-El-Dein and Samia A. Salama (2006) and El-Ganaini *et al.* (2008).

Phosphorus uptake was ranged between 4.54 and 20.16 mg P_2O_5 5 plants^{-1}. The lowest value of phosphorus uptake was obtained under application rate 100 mg N kg^{-1} of ChM with Cerealine, while the highest value was obtained under 50 mg N kg^{-1} of AS without biofertilization.

Application of 100 mg N kg^{-1} of AS or TR gave phosphorus uptake greater than application rates 50 and 75 mg N kg^{-1} of AS or TR. Application of 75 mg N kg^{-1} of ChM gave phosphorus uptake greater than application of rate 50 and 100 mg N kg^{-1}.

Regarding the effect of biofertilizers, the data show that without addition of biofertilizers gave phosphorus uptake greater than addition of biofertilizers. Data of inoculation are in agreement with those obtained by El-Zeky (2005) and Ibrahim *et al.* (2008).

Potassium Uptake

The data of Table 6 show potassium uptake (mg K_2O 5 plants^{-1}) of wheat plants at tillering, booting and harvesting stage. And can be discussed under subheading as follows:

a- Tillering stage

Potassium uptake ranged between 15.7 and 41.99 mg K_2O 5 plants^{-1}. The lowest value was obtained under application of 100 mg N kg^{-1} of AS and of Cerealine, while the highest value of potassium uptake was obtained under application rate 75 mg N kg^{-1} of ChM and Nitrobien.

Regarding the effect of nitrogen rate, data show that application rate 75 mg N kg^{-1} of AS gave potassium uptake greater than application of rates 50 or 100 mg N kg^{-1}. ChM or TR at the rate 100 mg N kg^{-1} gave potassium uptake greater than 50 and 75 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that under application of AS without addition of biofertilizers gave potassium uptake greater application of AS with Cerealine or Nitrobien. Under application ChM or TR, addition Nitrobien gave phosphorus uptake greater than addition Cerealine or without biofertilization.

b- Booting stage

Potassium uptake was ranged between 55.7 and 172.56 mg K_2O 5 plants^{-1}. The lowest value of potassium uptake was obtained

Table 6. Potassium uptake of wheat (mg/5 plants) as affected by sources and rates of nitrogen as well as biofertilizer addition sources at different stages.

N-Source (A)	N-Rate (mg N kg^{-1}) (B)	Tillering Stage			Booting Stage			Harvesting Stage					
								Straw			Grain		
		Without bio-add. * (C)	With bio-add. Cer. **	With bio-add. Nit. ***	Without bio-add.	With bio-add. Cer.	With bio-add. Nit.	Without bio-add.	With bio-add. Cer.	With bio-add. Nit.	Without bio-add.	With bio-add. Cer.	With bio-add. Nit.
A.S	50	19.84	22.82	17.53	102.92	87.36	60.83	401.21	783.00	775.01	160.11	123.22	77.38
	75	37.49	17.77	22.79	172.56	69.25	97.38	131.58	275.48	286.80	81.25	129.36	155.37
	100	26.70	15.70	23.46	111.83	76.74	136.50	550.19	210.17	239.98	149.64	113.93	144.32
Ch.M	50	29.38	27.19	40.32	168.57	56.54	67.28	388.28	964.07	963.07	136.80	98.77	79.66
	75	37.23	37.56	41.99	120.19	55.70	57.86	155.88	745.18	1207.01	139.22	81.18	58.84
	100	29.64	35.10	37.00	117.60	60.40	79.18	453.77	1058.40	969.14	94.19	38.56	50.09
T.R	50	27.38	24.72	26.62	111.61	123.63	130.48	373.69	495.94	383.83	186.71	69.50	62.39
	75	30.94	25.22	29.14	146.76	117.13	113.29	299.46	371.66	564.43	86.25	78.51	92.25
	100	20.44	30.26	40.36	107.52	116.81	91.65	441.94	466.47	717.42	147.31	85.28	104.67
No N addition		9.44	7.57	14.78	69.47	57.25	74.61	74.59	161.12	161.40	66.73	71.80	91.58

* Bio-add : Bio addition ** Cer : Cerealine *** Nit : Nitrobien

LSD :						
	A	2.14	7.53	10.67	75.14	
	B	2.47	8.70	12.32	86.77	
	AB	4.28	15.06	12.32	150.29	
	C	2.14	7.53	10.67	75.14	
	AC	3.70	13.04	18.47	130.15	
	BC	4.28	15.06	21.33	150.29	
	ABC	7.41	26.09	36.95	260.31	

under application rate 75 mg N kg^{-1} of ChM and addition of

Cerealine, The highest value was obtained under application rate 75 mg N kg^{-1} of AS without biofertilization.

Regarding the effect of nitrogen rate, data show that application rate 75 mg N kg^{-1} of AS or TR gave potassium uptake greater than application of rates 50 or 100 mg N kg^{-1}. Application rate 50 mg N $kg^{-1}$of ChM gave potassium uptake greater than application rates of 75 and 75 kg N $fed.^{-1}$.

Regarding the effect of using biofertilizers, the data show that without addition of biofertilizers gave potassium uptake greater than addition of biofertilization

c- Harvesting stage

Potassium uptake ranged between 131.58 and 1207.01 mg K_2O 5 $plants^{-1}$. The lowest value of potassium uptake was obtained under application rate 75 mg N kg^{-1} of AS and biofertilization, while the highest value was obtained under application rate 75 mg N kg^{-1} of ChM and Nitrobien.

Regarding the effect of nitrogen rate, data show that application rate 50 mg N kg^{-1} of AS gave potassium uptake greater than application of rates 75 or 100 mg N kg^{-1}. Application of 100 mg N kg^{-1} of ChM gave potassium uptake greater than application of 50 and 75 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that addition of Nitrobien gave potassium uptake greater than addition Cerealine or without biofertilization. Data of inoculation are in agreement with those obtained by El-Ganaini *et al.* (2008) and El-Maddah *et al.* (2005).

Potassium uptake ranged between 81.18 and 186.71 mg K_2O 5 $plants^{-1}$. The lowest value of potassium uptake was obtained under application rate 75 mg N kg^{-1} of AS without biofertilization, and the rate 75 mg N kg^{-1} of ChM with addition of Cerealine, while the highest value was obtained under application rate 50 mg N kg^{-1} of ChM without biofertilization.

Regarding the effect of nitrogen rate, data show that application rate 100 mg N kg^{-1} gave potassium uptake greater than application of 50 or 75 mg N kg^{-1}. Application rate 50 mg N kg^{-1} of ChM gave potassium uptake greater than application rates 75 and 100 mg N kg^{-1}.

Regarding the effect of using biofertilizers, the data show that without addition of biofertilizers gave potassium uptake greater than addition Cerealine or Nitrobien. Data of inoculation are in agreement with those obtained by El-Ganaini *et al.* (2008) and Mekail *et al.* (2005)

REFERENCES

Abd Rasoul, Sh. M., S. El-Saadany, N.S. Rizik and H. El-Taby (2003). Effect of phosphate fertilization and P-dissolving organisms (P.D.O) on wheat plant grown on ASandy soil in relation to their economic benefits. Egypt J. Appl. Sci., 17 : 127-142.

Amara, M.A.T. and M.S.A. Dahdoh (1997). Effect of inoculation with plant growth promoting rhizobacteria (PGRR) on yield and nutrients uptake by wheat grown on sandy soils. Egypt J. Soil Sci., 37(4) : 467-484.

Chapman, H.D. and P.F. Pratt (1961). Methods of Analysis of Soil, Plant and Water. Univ. of California Press. U.S.A.

El-Ganaini, S.S., Sawsan A. Seif El-Yazal and M.D.H. Dewdar (2008). Effect of soil application of nitrogen fertilizer and foliar NPK on vegetative growth, chemical composition, yield and yield components of wheat plants. Egypt J. Appl. Sci., 23(25) : 44-58.

El-Maddah, E.I., M.El-D. El-Soudany and E.A. Koureish (2005). Effect of *Azotobacter chroococcum* and phosphate solublizing bacteria on wheat growth, productivity and nutrient availability. J. Agric. Sci., Mansoura Univ., 30(5) : 2895-2908.

El-Zeky, M.M. (2005). Response of wheat to biofertilizer inoculation under different levels of inorganic nitrogen. J. Agric. Sci., Mansoura Univ., 30(1) : 701-710.

Fouda, S.E.E. (2007). Impact of biofertilizers on the yield attributes of wheat and remediation of environmental pollution. M.Sc. Thesis, Fac. of Agric., Zagazig Univ., Egypt.

Hesse, P.R. (1971). A text book of soil chemical analysis. John Marry (publishers) LTD., London.

Ibrahim, A.M., M.M. Mostafa, A.I. El-Garhi and N.N. Youssef (2008). Macronutrients uptake by maize plant and their availability in the soil as affected by organic fertilization under different sources and

levels of nitrogen. Zagazig J. Agric. Res., 35(5) : 1127-1142.

Jackson, M.L. (1967). Soil Chemical Analysis. Prentice – Hell, Inc., Englewood Cliffs, New Jersey.

Mekail, M.M., A.M. Ahmed and M.R. Mohamed (2005). Effect of nitrogen fertilizer levels and seeding rates and yield components of some wheat varieties. Minia J. of Agric. Res. Develp., 25(3) : 437-4760.

Meshref, H.A., Kh.H. El-Hamdi and E.E. Khafagi (2000). Use of biofertilization and organic manure to decrease the adverse environmental impacts of inorganic nitrogen in Agro-Ecosystem. J. Agric. Sci., Mansoura Univ., 25(1) : 555-569.

Nour El-Dein, M. and Samia A. Salama. (2006). Significance of biofertilization for improving yield, chemical and technological properties of wheat plants grown on saline soil. Zagazig J. Agric. Res., 33(3) : 501-515.

Peterburgski, A.V. (1968). Hand book of agronomic chemistry Kolos Publishing House, Moscow (in Russian pp: 29-86).

Piper, C.S. (1950). Soil and Plant Analysis. Interscience Publishers Inc., New York.

Sharief, A.E., S.E. El-Kalla, A.A. Leilha and H.E.M. Mostafa (1998). Response of some wheat cultivars to nitrogen fertilizer levels and biological fertilization. J. Agric. Sci., Mansoura Univ., 23(12) : 5807-5816.

Subba Rao, N.S. (1982). Biofertilizers in Agriculture. Oxford and IBH Publishing Co. New Delhi, Bombay, Calcutta, India.

Watanabe, F.S. and S.R. Olsen (1965). Test of an ascorbic acid method for detecting phosphorus in water and $NaHCO_3$ extracts from soil. Soil Sci. Soc. Am. Proc., 29 : 677-678.

إستجابة القمح للتلقيح بالسماد الحيوى تحت مصادر ومستويات مختلفة من النيتروجين

أسمـــاء عطيـــة شـــوقـــى خـــليل - عادل عبد الرحمن شيحة
صلاح محمود محمد دحدوح - أيمن محمود حلمى
قسم علوم الأراضى - كلية الزراعة - جامعة الزقازيق- مصر

أجريت تجربة أصص على نبات القمح خلال الموسم الشتوى 2006 بصوبة كلية الزراعة جامعة الزقازيق، بهدف دراسة تأثير الأسمدة الحيوية (السيريالين والنيتروبين) المحتوية على كائنات حية مثبتة للنيتروجين ، والأسمدة النيتروجينية العضوية (مخلفات الدواجن وخلفات المدن) والمعدنية (سلفات الأمونيوم) على نمو ومحصول القمح سخا 69 ، وكذلك محتواه من العناصر المغذية ، وذلك فى أرض طينية من مزرعة الكلية - أبو الأخضر - محافظة الشرقية. واحتوت التجربة على ثلاثة عوامل هى : التلقيح وعدم التلقيح بالسيريالين والنيتروبين ، ومصادر النيتروجين ، ومعدلات الإضافة. حيث تم التلقيح بالمخصب الحيوى بمعدل 14 جم / كجم حبوب ، كما تم إضافة النيتروجين على صورة سلفات أمونيوم ومخلفات دواجن ومخلفات مدن بثلاثة معدلات هى 50 ، 75 ، 100 ملجم نيتروجين / كجم على دفعتين ، والتجربة تضمن عاملين وكاملة العشوائية. وقد أظهرت النتائج ما يلى : أعلى قيمة من وزن القش والنيتروجين الممتص كانت عند إضافة المعدل 100 ملجم نيتروجين / كجم من سلفات الأمونيوم مع التلقيح بالنيتروبين ، فى حين أن محصول الحبوب كانت أكبر قيمة له عند إضافة المعدل 75 ملجم نيتروجين / كجم من مخلفات الدواجن بدون تلقيح ميكروبى ، وكانت أعلى قيمة من النيتروجين الممتص بواسطة الحبوب عند إضافة المعدل 100 ملجم نيتروجين / كجم من مخلفات الدواجن مع التلقيح بالنيتروبين. وبينما كانت أعلى قيمة لامتصاص الفوسفور والبوتاسيوم تم الحصول عليها عند إضافة المعدل 75 ملجم نيتروجين / كجم من مخلفات الدواجن مع التلقيح بالنيتروبين , كما أن أعلى قيمة لامتصاص الفوسفور بواسطة الحبوب كانت عند إضافة المعدل 50 ملجم نيتروجين / كجم من سلفات الأمونيوم بدون تلقيح ميكروبى ، أما البوتاسيوم الممتص فكانت أعلى قيمة له عند استخدام المعدل 50 ملجم نيتروجين / كجم من مخلفات الدواجن بدون تلقيح ميكروبى.