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EFFECT OF INOCULATION WITH BIOFERTILIZER, NK FERTILIZATION RATES AND FOLIAR APPLICATION OF MICRONUTRIENTS ON GROWTH, YIELD AND CHEMICAL CONTENTS OF WHEAT PLANTS.

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ABSTRACT: *A field experiment was carried out at El – Makrany Village, Yousef El- Sadeek District, El- Fayoum Governorate during the two successive seasons of 2008/2009 and 2009/2010 to study the effect of inoculation with biofertilizer(cerealin), nitrogen and potassium fertilization at rates of 50, 75 and 100% of the recommended rate /fed. with foliar spraying of micronutrients (Fe, Zn and Mn) and their interactions on plant growth, yield and its components as well as chemical composition of wheat plants (c.v. Sakha 93)*

Application of the tested rates of nitrogen and potassium induced significant increase in vegetative characteristics (plant height, fresh and dry weight /plant, 1000-grain weight, grain weight /spike, grain and straw yield/fed.) as well as N,P and k content in the grains and straw and micronutrients uptake in the grains.

Also, plant height, chlorophyll content, fresh and dry weights / plant, grain and straw yield/fed., and N,P and K uptake in grains and straw, micronutrients contents (Fe, Zn and Mn) in grains gave the highest values with inoculation by biofertilizer (cerealin) and foliar spraying of micronutrients

The interaction between NK, inoculation by cerealin and micronutrients gave the highest values of vegetative growth characteristics, and N, P and K content in grains and straw and micronutrients (Fe, Zn and Mn) in grains when wheat plant was fertilized with 75% or 100% NK of the recommended rate and inoculation with cerealin plus foliar spraying by micronutrients as well as grains and straw yield/fed., protein content of grain, N, P and K uptake of both grain and straw, while the lowest values were recorded with 50% NK of recommended rates alone .

Generally, the best results were obtained when wheat received 75% or 100% of NK of the recommended rate, inoculated by cerealin and sprayed with micronutrients. These treatments resulted in the highest yield and its components

Key words: *Wheat, NK fertilizer, Yield, Biofertilizer, Micronutrients and Chemical composition.*

INTRODUCTION

Wheat (*tritlcum aestivum L.)* is one of the most important cereal crops in Egypt and overall the world used principally as human food. Wheat provides 37% of the total calories and 40% of the protein in the Egyptian people diet. Total production of wheat in Egypt reached 8.184 million tons in 2006, produced from an area of 3.004 million feddan, with average yield of 18.162 ard. /fed. (Zaki *etal.,* 2007). Recently a great attention of several Egyptian investigators has been directed to increase the productivity of wheat to minimize the gap between the production and consumption through increasing unit land area productivity and increasing cultivated area. Increasing wheat yield per unit area can be achieved by using the breed high yielding varieties and applying the optimum cultural practices.

Nitrogen is the most important essential nutrient in plant nutrition, it is a constituent of a large number of necessary organic compounds such as amino acids, proteins, coenzymes, nucleic acids, ribosomes, chlorophyll, cytochrom and some vitamins (Marschner , 1986). The positive effects of applying nitrogen fertilizer on growth, yield attributes, grain yields and quality of wheat were reported by Hossain *etal.*, (2005).

Although potassium is not a structural component of plants, it is one of the most important nutrients with respect to its physiological and biochemical functions. Potassium plays an important role in many of the vital physiological process in the plant, such as transpiration, translocation of sugars and starch, protein formation and osmotic regulation. Several enzyme systems requiring potassium (e.g pyruvate kinas, nitrate reductase and activation of ATPase systems). Potassium application might have an important effect in improving maize growth and increasing grain yield and its quality (EL – Aref *etal.*, 2004 and Ewais *et al* ., 2010).

Biofertilization technologies are based on enhancing and improving the naturally existing nutrients transformation activities in soil profile. (Ashoush and Abd El –Moniem 2001). Also, they concluded that the application of bio-fertilizers provide to be a sustainable way for increasing crop yields, reducing the use of chemical fertilizers and improving soil fertility, and they added that bio- fertilizers have an effective role for N-fixation and biomass accumulation beside their favorable effect on mineralization , reclamation of sick soils and balance of soil N . Many investigators found that inoculation of wheat grains with biofertilizer(cerealin) significantly improved wheat plants growth, yield and its components (Abd El- Rasoul *etal.*, 2003; Ibrahim *et al.*, 2004 and Zeidan *et al.*, 2005)

Micronutrients play an important role in most vital processes of plants, although they are needed in small quantities (Marschner, 1995). Who added that the enhancing effect of micronutrients addition on the content of photosynthetic pigments of plant leaves could be explained by its beneficial

effects on the number of chloroplasts per cell or by farming chloroplasts with high chlorophyll content. On the other hand, the superior impact of Fe – element might be due to the essential roles of Fe in the redox reactions of chloroplasts, in the mechanism of photosynthetic electron transfer and also in the formation of heme and nonheme, proteins, concentrated in chloroplasts. Numerous investigators came to the same conclusion, (e.g Nassar, 1997) on wheat. Zinc is essential for plant metabolism (as an activator of several enzymes) of carbohydrates, protein, phosphates, RNA synthesis and tryptophan(the precursor of growth phytohormon the indole acetic acid), chlorophyll synthesis, photosynthesis as well as its role as co-factor of various enzymes, which act on phosphorylated substrates (Mohr and Schopfer, 1995). Manganese plays a role in regulating the level of auxin, in photosynthetic apparatus synthesis. The best-defined function of manganese is in the photosynthetic reaction in which oxygen is produced from water (Marschner, 1995). It is an essential factor in respiration and nitrogen metabolism; it functions as an enzyme activator. Manganese appears to be essential for some reaction in the metabolism of the plant. Enzymes of the Krebs cycle require the presence of manganese as an activator (Devlin, 1975).

The objectives of this study were to determine the effect of inoculation with biofertilizer, NK fertilization rates and foliar application of micronutrients on growth, yield and quality of wheat as well as to investigate the possibility of reducing the mineral fertilizer application and avoid environmental pollution.

MATERIALS AND METHODS

A field experiment was conducted at El- Makrany Village, Yousef El-Sadeek District, El-Fayoum Governorate(29° 22˙ 25.69˝ N - 30° 37˙ 50.69˝ E – elevation 5 m) during the two winter growing seasons of 2008/2009 and 2009/2010, to study the individual and combined effects of inoculation with biofertilizer, NK fertilizer rates and foliar application of micronutrients on growth, yield and quality of wheat plants (c.v. Sakha 93).Some physical and chemical properties of the experimental soil at the depth of 0-30 cm were determined according to (Page *et al.*, 1982) as shown in Table (1). Wheat grains were inoculated with cerealin (seed coating of one g/100g wheat grains) directly before planting. Arabic gum (0.2%) was used as an adhesive agent.

In this study, a mixture of compound chelated (EDTA form) micronutrients contain 13,13 and 15 % of Fe, Mn and Zn, respectively was used. Also, phosphorus fertilizer was added in the form of calcium superphosphate (15% P_2O_2) once during soil preparation at the rate of 15 kg P_2O_2 /fed. The plot area was 10.5 m^2 (3x3.5 m), i.e.1/400 fed. Wheat grains (Sakha 93 cv.) were sown at

21st and 29th November and harvested at 11th and 17th May during the first and second season respectively.

The experimental design

The experimental plots were arranged in split plot design with three replicates. Nitrogen and potassium fertilizers were applied at three levels 50,75and 100 %. of the recommended rates, where the recommended rates of N and K fertilizers for wheat plant were 80 and 48 N and K_2O /fed., respectively. The treatments of N and K were randomly distributed in main plots. Ammonium sulphate (20.6 % N) was added in three equal doses after 4,6 and 8 weeks from planting date and potassium sulphate (48 % K_2O) was added twice , one half with first dose and second half with third dose of N fertilizer.

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

Soil characteristics and units	Value
Practical size distribution (%)	
Coarse sand	7.20
Fine sand	21.12
Silt	23.95
Clay	47.73
Textural class	clay
Soil chemical analysis :	
pH(1:2.5 soil:water suspension)	8.25
Calcium carbonate %	12.58
Organic matter %	1.85
EC in dSm^{-1} (soil paste)	3.17
Soluble cations (meq/l)	
Ca^{++}	8.42
Mg^{++}	4.28
Na^{+}	18.50
K^{+}	0.50
Soluble anions (meq/l)	
HCO^{-}_3	2.75
$CO_3^{=}$	0.00
Cl^{-}	20.84
$SO_4^{=}$	8.11
Available nutrients (mg/kg)	
N	17.40
P	4.65
Fe	3.25
Mn	0.76
Zn	0.43

Subplots occupied for control, inoculated with cerealin, mixture of micronutrients at rate of 150, 75 and 75 mg/l for Fe,Mn and Zn, respectively as alone or in combination with biofertilizer. The mixture of micronutrients was applied twice after 4 and 8 weeks from planting

Data Recorded

At heading stage (100 days from sowing) a representative samples of flag leaf were taken from each experimental plot for chlorophyll determination using the method described by (Moran 1982).In this samples fresh and dry weight of whole plants were recorded. Also, N, P and K-uptake in samples were determined using the methods described by (Cottenie *et al.*, 1982).

At harvesting stage, ten plants were taken from each plot to determine: plant height (cm), spike length (cm), number of grain /spike, grain weight/spike (g) and weight of 1000-grain (g). Also, grain and straw yields /fed. were recorded. Nitrogen, P and K, Fe, Zn and Mn were determined in grains using the methods described by (Chapman and Pratt 1961). Crude protein in grains (kg/fed.) was determined by multiplying the corresponding values of N-content by 5.75 and total carbohydrates content kg/fed. was determined as described by (A.O.A.C. 1980).

Results for all studied parameters were statistically analyzed using the combined analysis of the two growing seasons according to (Gomez and Gomez 1984). The significant differences among means were tested using the least significant differences (L.S.D.) at 5% level of significance.

RESULTS AND DISCUSSION

I-Vegetative Growth Characteristics

a-Effect of nitrogen and potassium rates

Data presented in Table (2) indicate that the vegetative growth characters of wheat, i.e. chlorophyll content, fresh and dry weight/plant, and N, P and K uptake were varied significantly by the addition of N and K at different rates. The highest values of all parameters under study were recorded at the rate of 75 or 100% NK of the recommended rates. The increase of these characters could be due to the increase in the amount of metabolites synthesized by plants as a result of increasing nitrogen fertilizer levels on the metabolic processes and physiological activities of meristimatic tissues, which are responsible for cell division and elongation in addition to formation of plant organs , this lead to more vigorous and consequently accumulation of more photosynthesis assimilates. Similar results were reported by (El- Naggar 1999, Darwish, 2003 and Zohry and Farghaly 2003). On the other hand, potassium is necessary for the activation of some enzyme systems, carbohydrates metabolism or formation and translocation of carbohydrate, control and regulation of activities of various essential elements (Said *et al.*, 1996). Therefore N and K enhance the amount of metabolites necessary for building plant organs consequently vegetative growth of plant. Similar observations were reported by (El-Banna and Gomaa 2000 and El-Aref *et al.*, 2004).

Table (2): Effect of NK rates, micronutrients, inoculation with bio-fertilizer and their interactions on chlorophyll content (mg/g f.w.), fresh and dry weight (g/plant), N, P and K- uptake (mg/plant) (combined analysis of 2008/2009 and 2009/2010 growing seasons)

Characteristics / Treatments		Chlorophyll (mg/g F.W.)			F.W. * (g/plant)	D.W.** (g/plant)	Nutrients uptake (mg/plant)		
		a	b	a+b			N	P	K
50 % NK of -(RR)	control	3.53	1.38	4.91	29.80	8.70	199	30.5	144
	Bio +	3.66	1.45	5.11	35.60	12.10	290	47.2	224
	Micro++	3.69	1.52	5.21	32.80	10.30	242	38.1	182
	Bio+Micro	3.77	1.64	5.41	37.50	12.80	314	53.8	248
	mean	3.66	1.50	5.16	33.93	10.98	261	42.4	200
75 % NK of -(RR)	control	3.67	1.45	5.12	32.50	11.00	261	42.9	197
	Bio	3.83	1.68	5.51	39.40	13.30	330	58.5	263
	Micro	4.29	1.76	6.05	36.20	12.20	299	51.2	227
	Bio+Micro	4.44	1,85	6.29	42.60	15.50	397	71.3	326
	mean	4.06	1.69	5.74	37.68	13.00	322	56.0	253
100 % NK of -(RR)	control	3.78	1.56	5.34	44.60	15.80	410	69.5	307
	Bio	3.91	1.82	5.73	49.40	17.30	458	83.0	391
	Micro	4.43	1.89	6.32	47.40	16.20	424	72.9	356
	Bio+Micro	4.51	1.97	6.48	51.60	17.80	481	92.9	422
	mean	4.16	1.81	5.97	48.25	16.78	443	79.6	369
Mean of bio+ micro	control	3.66	1.46	5.12	35.63	11.83	290	47.6	513
	Bio	3.80	1.65	5.45	41.47	14.23	360	62.9	293
	Micro	4.14	1.72	5.86	38.80	12.90	322	54.1	255
	Bio+Micro	4.24	1.82	6.06	43.90	15.37	397	72.7	332
L.S.D. at 5 %level									
NK fert. (A)		0.04	0.03	0.05	2.38	0.13	19.98	0.71	3.27
Bio+Micro (B)		0.02	0.02	0.03	1.60	040	17.05	1.68	7.76
Interaction (AxB)		3.85	3.48.	0.06	n.s.	0.69	n.s.	2.91	13.44

*F.W.: Fresh weight
** D.W.: Dry weight
+ Biofertilizer (cerealin)
++ Micronutrients (Fe,Zn,Mn)
-RR : Recommended rate

b-Effect of biofertilizer and micronutrients:

Table (2) shows clearly that mixing cerealin as bio-N- fertilizer with grains of wheat at sowing time resulted in an increment in values of all plant growth measurements under study, if compared with the untreated plants, it could be concluded that cerealin increased chl.a, chl.b and total chlorophyll in wheat leaves, fresh and dry weight and N, P and K-uptake compared with control. Such superiority may be attributed to that applying cerealin

enhanced the activity of soil microorganisms which convert nutrients such as nitrogen from organic form to mineral one. This reflexed to increase the uptake of nutrients from soil (El- Kabbany and Darwish 2002). The highest values of fresh and dry weights and also N, P and K-uptake were obtained with using cerealin and micronutrients in combination, while control treatment gave the lowest values. This results could be attributed to 1- the availability of more N fixation by free living bacteria which present in biofertilizer 2- the production of growth regulators substances such as indol acetic acid, gibberellins, pyridoxine and others which stimulates plant growth and subsequently affect wheat yield and its attributes. Such results are in agreement with those obtained by Metwaly (2000) and Massoud *et al*, (2004).

Concerning the effect of micronutrients on plant growth, data in Table(2) showed that foliar application of Fe,Mn and Zn enhanced wheat plant growth i.e. chl.a ,chl.b and total chlorophyll in wheat leaves , fresh and dry weight, N, P and K- uptake compared with control . The positive effect of micronutrients on vegetative growth characteristics might be due to their effects on photosynthesis process through chlorophyll formation and activated of some enzymes as dehydrogenises in plants compared with control (Marschner, 1995). Alam(2006)reported that, foliar supply of micronutrients can result in increasing the photosynthetic efficiency and it is possible to modify the physiology of leaf.

c- The interaction between NK rates, bio-fertilizer and micronutrients

Data in Table (2) illustrate that, the interactions between NK rates and biofertilizer inoculation with micronutrients had significant effects on chlorophyll content, fresh and dry weight/plant, P and K-uptake.

II-Yield And Its Components

a-Effect of nitrogen and potassium rates

Data illustrated in Table (3) show that, plant height, spike length, 1000-gain weight, No. of grains /spike, grain weight/spike and grain and straw yield/fed. were significantly increased with increasing nitrogen and potassium rates. The relative increases over control, reached to 8.61, 30.61, 8.41, 12.29, 15.21, 34.08 and 26.94% for each of plant height, spike length, 1000-grain weight, No. of grains/spike, grain weight /spike, grain yield and straw yield, respectively. These increases mean that nitrogen is one of the most important components of cytoplasm, nucleic acids and chlorophyll, so nitrogen has an important role in encouraging cell elongation, cell division and consequently increasing vegetative growth and activation of photosynthesis process which enhance the amount of the metabolites necessary for building plant organs which reflect increases in grain and

straw yields. It may also state that the sufficient application and the efficient absorption of N and K were coupled together to promote the production of more photosynthesis required for good grain yield and its components. These results are in agreement with those reported by (El – Banna and Gomaa 2000, Yakout and Greish 2002 and El- Aref *et al.*, 2004).

Table (3): Effect of NK rates, micronutrients, inoculation with bio-fertilizer and their interactions on yield and yield components of wheat (combined analysis of 2008/2009 and 2009/2010 growing seasons)

Characteristics / Treatments		Plant height (cm)	Spike length (cm)	1000-grain weigh (g)	No. of grains /spike	Grain weigh/ spike (g)	Grain yield (kg/fed.)	Straw yield (kg/fed.)
50 % NK of -(RR)	control	105.7	9.8	44.0	40.7	2.17	2318	2970
	Bio+	113.2	11.9	47.8	45.3	2.28	2652	3260
	Micro++	110.3	11.1	45.4	43.7	2.19	2450	3120
	Bio+Micro	114.5	12.4	49.7	47.0	2.35	2928	3470
	mean	110.93	11.3	46.7	44.2	2.25	2587	3205
75 % NK of -(RR)	control	110.5	11.5	45.0	43.7	2.43	2588	3380
	Bio	118.6	12.9	49.5	47.7	2.59	3080	3660
	Micro	114.4	12.7	47.8	45.3	2.48	2823	3450
	Bio+Micro	119.9	13.8	50.2	51.7	2.67	3233	3940
	mean	115.85	12.7	48.1	47.1	2.54	2931	3608
100 % NK of -(RR)	control	114.8	12.8	47.7	45.7	2.50	3108	3770
	Bio	120.5	13.6	50.6	50.3	2.77	3417	4450
	Micro	118.2	13.4	49.8	46.3	2.63	3285	4260
	Bio+Micro	124.3	14.7	53.8	54.0	2.85	3663	4760
	mean	119.45	13.6	50.5	49.1	2.69	3368	4310
Mean of bio+ micro	*control*	110.33	11.4	45.6	43.3	2.37	2671	3373
	Bio	117.43	12.8	49.3	47.7	2.55	3050	3790
	Micro	114.30	12.4	47.7	45.1	2.43	2853	3610
	Bio+Micro	119.57	13.6	51.2	50.9	2.62	3275	4057
L.S.D. at 5 %level								
NK fert. (A)		1.57	0.12	2.79	1.45	0.03	38.51	18.40
Bio+Micro (B)		2.17	0.10	1.54	1.69	0.03	36.14	29.07
Interaction (AxB)		n.s.	0.18	n.s.	n.s.	5.17	62.59	50.34

+ Biofertilizer (cerealin)
++ Micronutrients (Fe,Zn,Mn)
-RR : Recommended rate

b-Effect of biofertilizer and micronutrients

The results in Table (3) reveal that inoculation with biofertilizer or the addition of micronutrients singly or combined significantly increased wheat yield and yield components compared with untreated plants. The beneficial effect of biofertilizer on yield and its components is attributed to the vigorous growth of plants and the amount of metabolites synthesized by the plant and to the role of biofertilizer in absorbing nutrients, especially N, P, Fe,Zn and Mn which play an important role in activation of the metabolic processes. In addition, the amounts of N- fixation were increased by biofertilizer, plant

growth regulators production and antimicrobial substance production that could be useful against pathogenic microorganisms. Similar finding were obtained by Abd El- Rasoul *et al.*, (2003), El-Sebsy and Abd El – Maaboud (2003), Ibrahim *et al.*, (2004) and Zeidan *et al.*, (2005). Moreover, effect of micronutrients (Fe, Zn, Mn) on yield and its components might be attributed to their positive photosynthetic process and as an activator for IAA oxidase and carbohydrate assimilation. Nofal, (1998) reported that foliar fertilization with chelated micronutrients gave the highest tuber yield of potato. The positive effect of zinc might be due to its function as catalyst or stimulant in most of the physiological and metabolic processes and metal activator of enzymes, resulting in growth and development, which ultimately gave higher yield and yield components (Singh *et al.*, 2004).

The significant favorable effect of manganese as reported by Shaban *et al.*, (2010) may be due to the physiological role of this nutrient on enzymes synthesize and function on plant growth as well as yield and its components. The promotive action of ferrous may be due to that ferrous involved in photosynthesis and mitochondrial respiration (Gurmani *et al.*, 2003).

c- The interaction between NK- rates, biofertilizers and micronutrients:

Concerning the interaction between NK rates and biofertilizer with micronutrients on wheat yield and its components, data in Table (3) reveal that the maximum values for yield and yield components of wheat were obtained under treatment the soil by 100% NK (recommended rate) + bio + micronutrients. The relative increases over control, reached to 17.60, 50.00, 22.27, 32.68, 31.34, 58.02 and 60.27% for each of plant height, spike length, 1000- grain weight, No. of grains/spike, grain weight/spike, grain yield and straw yield; respectively.

III-Chemical constituents

a-Effect of nitrogen and potassium rates:

Data in Tables (4 and 5) show that by increasing NK rates , the N,P and K concentration and their uptake in grains and straw were increased until reaching the maximum (27.78%,13.79%,27.27% and 71.33%, 52.68%,69.96 %) for NPK concentration and uptake in grains; respectively by the treatment 100% mineral fertilizers alone as compared to control treatment (50% mineral fertilizers alone).Also, NPK concentration and uptake in straw were significantly increased by (28.57%,25%,16.13% and 63.17%,58.75%,47.39%) respectively .Such results might be attributed to the role of nitrogen nutrient in increasing the root surface per unit of soil volume and also the capacity of the plant supplied with N in building metabolites which increases the dry matter content and subsequently increases nutrients uptake by wheat plants, (Kotb, 1998 and El-Naggar 1999). Also, K encourages various enzymes and

photosynthesis as well as plant root development which in turn resulted in higher dry matter accumulation in grains. Moreover K enhances translocation of metabolites synthesized from leaves to grains. Supportive evidences with these results were reported by Ghallab and Salem (2001) on wheat plants.

Table (4): Effect of NK rates, micronutrients, inoculation with biofertilizer and their interactions on NPK concentration and uptake in grains (combined analysis of 2008/2009 and 2009/2010 growing seasons)

Characteristics / Treatments		nitrogen		phosphorous		potassium	
		(%)	(Kg/fed.)	(%)	(Kg/fed.)	(%)	(Kg/fed.)
50 % NK of -(RR)	control	1.80	41.72	0.29	6.72	0.55	12.75
	Bio+	1.90	50.39	0.32	8.49	0.59	15.65
	Micro++	1.85	45.32	0.30	7.35	0.57	13.96
	Bio+Micro	1.95	57.10	0.34	9.96	0.60	17.57
	mean	1.88	48.63	0.31	8.13	0.58	14.98
75 % NK of -(RR)	control	2.15	55.63	0.31	8.02	0.64	16.56
	Bio	2.25	59.29	0.34	10.47	0.66	20.32
	Micro	2.20	62.11	0.32	9.03	0.62	17.50
	Bio+Micro	2.28	73.70	0.35	11.31	0.67	21.66
	mean	2.22	65.18	0.33	8.71	0.65	19.01
100 % NK of -(RR)	control	2.30	71.48	0.33	10.26	0.70	21.67
	Bio	2.35	80.30	0.36	12.30	0.77	26.31
	Micro	2.32	76.54	0.34	11.17	0.75	24.64
	Bio+Micro	2.37	86.81	0.38	13.92	0.79	28.94
	mean	2.34	78.78	0.35	11.91	0.75	25.41
Mean of bio+ micro	*control*	2.08	56.28	0.31	8.33	0.63	17.02
	Bio	2.17	66.66	0.34	10.42	0.76	20.76
	Micro	2.13	61.32	0.32	9.18	0.65	18.70
	Bio+Micro	2.20	72.54	0.36	11.73	0.69	22.72
L.S.D. at 5 %level							
NK fert. (A)		0.02	2.01	0.01	0.21	0.01	0.29
Bio+Micro (B)		0.02	1.87	0.01	0.44	0.02	0.54
Interaction (AxB)		n.s.	3.24	n.s.	n.s.	n.s.	0.93

+ Biofertlizer (cerealin)
++ Micronutrients (Fe,Zn,Mn)
-RR : Recommended rate

b-Effect of biofertilizer and micronutrients:

From the data in Tables (4 and 5), it can be observed that inoculated wheat plants and micronutrients application as compared to control ones were more rich in N, P and K concentration and their uptake in both grains and straw. The greatest increase were obtained by inoculated with cerealin and micronutrients in combination with 100 % mineral fertilizers, which reached (31.67 %, 31.03 %, 43.64 % and 108.08 %, 107.14 %, 126.98 %) for N, P and K concentration and uptake of grains respectively.

Table (5): Effect of NK rates, micronutrients, inoculation with biofettlizer and their interactions on NPK concentration and uptake in straw (combined analysis of 2008/2009 and 2009/2010 growing seasons)

Characteristics / Treatments		nitrogen		phosphorous		potassium	
		(%)	(Kg/fed.)	(%)	(Kg/fed.)	(%)	(Kg/fed.)
50 % NK of -(RR)	*control*	0.35	10.40	0.20	5.94	1.55	46.04
	Bio+	0.38	12.39	0.24	7.82	1.59	51.383
	Micro++	0.36	11.23	0.23	7.18	1.56	48.67
	Bio+Micro	0.40	13.88	0.25	8.68	1.62	56.21
	mean	0.37	11.98	0.23	7.41	1.58	50.69
75 % NK of -(RR)	*control*	0.40	13.52	0.23	7.77	1.69	57.12
	Bio	0.46	16.84	0.25	9.15	1.75	64.05
	Micro	0.44	15.18	0.24	8.28	1.73	59.69
	Bio+Micro	0.50	19.70	0.27	10.64	1.77	69.74
	mean	0.45	16.81	0.25	8.96	1.74	62.65
100 % NK of -(RR)	*control*	0.45	16.97	0.25	9.43	1.80	67.86
	Bio	0.52	23.14	0.27	12.02	1.85	82.33
	Micro	0.48	20.45	0.26	11.08	1.82	77.53
	Bio+Micro	0.55	26.18	0.28	13.33	1.88	89.49
	mean	0.50	22.50	0.27	11.47	1.84	79.30
Mean of bio+ micro	*control*	0.40	13.63	0.23	7.71	1.68	57.01
	Bio	0.45	17.46	0.25	9.66	1.73	66.07
	Micro	0.43	15.62	0.24	8.85	1.70	61.96
	Bio+Micro	0.48	19.92	0.27	10.88	1.76	71.81
L.S.D. at 5 %level							
NK fert. (A)		0.02	0.61	0.01	0.61.	0.02	0.85
Bio+Micro (B)		0.02	0.60	0.01	0.53	0.03	0.96
Interaction (AxB)		n.s.	1.04	n.s.	n.s.	n.s.	1.67

+ Biofertlizer (cerealin)
++ Micronutrients (Fe,Zn,Mn)
-RR : Recommended rate

Also (57.14 %, 40 %, 21.29 % and 151.73 %, 124.41 %, 94.37 %) for N, P and K concentration and uptake of straw respectively, compared with 50 % mineral fertilizers alone. The positive effect of cerealin inoculation upon nutrients uptake could be ascribed to the high efficiency of bacteria presence in this biofertilizer to fix atmospheric nitrogen and/ or produce some biologically active substances, e.g. indol acetic acid, gibberellins and cytokinine like substances. Such substances would increase the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (El-Naggar 1999). El-Kabbany and Darwish (2002) found that grains and straw of wheat plants treated with 30 or 60 kg N plus cerealin inoculation contained great amount of N, P and K compared to those treated with 30 or 60 kg N /fed. alone. Kotb, (2005) reported that Azotobacter and Asospirillum strains produced adequate amounts of IAA and cytokinines, which increase the surface area per unit root length and are responsible for root hair branching and eventually increase the uptake of nutrients. These results are in agreement with that obtained by Metwally (2000) and Helmy (2008).

Application of micronutrients produced the highest percentage of N, P and K in grains and straw with significant improvement over control treatment. Such improvement could be explained by the role of these elements in increasing adsorbing surface of the root and improves transportation of the nutrients from the soil to plant organs via the roots. Similar results were obtained by Abd El-Magid *et al*, (2000) and Shaban *et al*., (2010).

c-The interaction between N K rates, biofertilizer and micronutrients:

Results in Tables (4 and 5) reveal that, the interaction between N K rates, biofertilization and micronutrients on N, P and K concentration and their uptake in grains and straw were insignificant except N and K-uptake in grains and straw were significant. The highest values in N, P and K % in grains and straw were obtained at interaction of using N K at rates of 75% and 100% of the recommended rates with N- biofertilization in the presence of foliar application of micronutrients.

IV- Grain quality:

a-Effect of nitrogen and potassium rates :

Data in Table (6) indicate that Fe,Zn and Mn uptake in the grains were significantly increased by increasing the N K rates. Wheat plants fertilized with 100% N and K of recommended rate gave the highest value of Fe,Zn and Mn concentration compared with 50% of recommended rate. These results may be due to the effect of N and K on plant growth and consequently on the efficiency of the root in absorbing various nutrients. The obtained results are in agreement with those reported by Ghallab and Salem (2001).

Also, data presented in Table (6) show that quality of wheat grains as protein %, carbohydrate %, protein and carbohydrate yield / fed. were significantly affected by addition of NK rates. The highest values of protein content were obtained at 100% NK of recommended rate /fed. while the lowest values of protein content in wheat grains were recorded in the wheat grain applied with 50% NK of the recommended rate /fed.On the other hand , the highest values of carbohydrate % were obtained at 75%NK of the recommended rate/ fed. the favorable effect of higher N dose on grain quality might be due to that N increases photosynthetic pigments content and photosynthesis rate which in turn increased the amount of metabolites synthesized and consequently resulted in higher dry matter accumulation in grains . Similar results reported by El-Banna and Gomaa (2000), Darwish (2003) and Zohry and Faraghaly (2003). Also, these results might be due to the important role of potassium in activation synthesis of protein and many other compounds including starch, sugar, cellulose, cell wall and vitamins. Also, K encourages various enzymes and photosynthesis as well as plant

root development. These results are in a same trend with those found by El-Banna and Gomaa (2000) and El-Araf *et al.*, (2004).

Table (6): Effect NK rates, micronutrients, inoculation with biofertilizer and their interactions on grain quality (combined analysis of 2008/2009 and 2009/2010 growing seasons)

Characteristics / Treatments		Fe (g/fed.)	Mn (g/fed.)	Zn (g/fed.)	Protein		carbohydrate	
					%	Kg/fed.	%	Kg/fed.
50 % NK of -(RR)	control	271	139	93	10.35	240	60.88	1411
	Bio+	318	167	114	10.93	290	64.28	1705
	Micro++	306	162	113	10.64	261	62.96	1542
	Bio+Micro	372	199	143	11.21	328	65,76	1925
	mean	317	167	116	10.78	280	63.47	1646
75 % NK of -(RR)	control	313	160	111	12.36	320	63.52	1644
	Bio	388	200	148	12.94	399	66.58	2050
	Micro	376	195	147	12.65	357	64.72	1827
	Bio+Micro	443	233	178	13.11	424	68.16	2203
	mean	380	197	146	12.77	375	65.75	1931
100 % NK of -(RR)	control	410	199	140	13.23	411	66.44	2065
	Bio	475	232	191	13.51	462	69.32	2369
	Micro	476	246	194	13.40	440	67.54	2219
	Bio+Micro	542	282	227	13.63	499	71.09	2604
	mean	476	240	188	13.44	453	68.60	2314
Mean of bio+ micro	*control*	332	166	115	11.98	324	63.61	1706
	Bio	394	200	151	12.46	383	66.73	2041
	Micro	386	201	151	12.23	353	65.07	1862
	Bio+Micro	452	238	183	12.65	417	68.34	2244
L.S.D. at 5 %level								
NK fert. (A)		6.88	5.97	3.69	0.11	5.05	2.83	21.93
Bio+Micro (B)		7.56	6.27	5.91	0.14	4.74	2.99	10.87
Interaction (AxB)		13.10	10.86	10.25	n.s.	8.21	n.s.	18.84

+ Biofertlizer (cerealin)
++ Micronutrients (Fe,Zn,Mn)
-RR : Recommended rate

b-Effect of biofertilizer and micronutrients :

Data in Table (6) reveal that inoculation with cerealin as biofertilizer in combination with foliar spraying of micronutrients had significant positive effect on Fe,Zn and Mn uptake in grains of wheat compared with the control . The positive effect of inoculation upon nutrient uptake could be attributed to the high efficiency of bacteria presence in biofertilizer cerealin to fix atmospheric nitrogen and / or to produce some biologically active substances, e.g. IAA, gibberellins and cytokinine – like substances. These substances greatly help in increasing the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (kotb, 1998). Moreover, it may be attributed to the effect of micronutrients on stimulating biological activities, i.e. enzyme activity, rate of photosynthetic products and increasing nutrient uptake through roots after application

(Shaban *et al.*, 2010). These results coincide with those obtained by Mohammed (2008), who found that, the micronutrients enriched with NPK fertilizer increases the concentrations of micronutrients in rice grains.

Presented data in Table (6) show also, that the effect of inoculation with cerealin and foliar spraying of micronutrients each alone or in combination, significantly affected the protein %, carbohydrate %, protein and carbohydrate yield/fed. in wheat grains. The highest percentage of protein and carbohydrate in grains were obtained by inoculation with cerealin and micronutrients application. These results may be attributed to improve mineral nutrition uptake and increasing the photosynthetic efficiency. The increase in carbohydrate percentage may have been due to the effect of those nutrients on chlorophyll concentration, activation of carboxylation and dehydrogenese enzymes of CO_2-fixation (Kumar and Prasad, 1986).However, the increase in crude protein percent was ascribed to effect on RNA synthesis which in turn plays an important role in protein biosynthesis, activity of nitrate reductase in leaves. These results are in agreement with those of Abd El-Hady *et al.* (2006)

c-The interaction between NK rates, biofertilizer and micronutrients:

Data presented in Table (6) show that, the interaction between NK rate with inoculation by cerealin and foliar application of micronutrients had significant effect on micronutrients. The maximum values of Fe, Zn and Mn were recorded at 100% 0f NK fertilizers of the recommended rate under inoculation by cerealin with application of micronutrients (Fe, Zn and Mn). Also, data in Table (6) show that, the interaction between NK rate with inoculation by cerealin and foliar spraying of micronutrient gave the highest significant for protein and carbohydrates yield.

Conclusion:

According to the previous discussion and results, it could be concluded that raising NK fertilizer from 50 to 100% of the recommended rate increased the wheat yield and most studied characters. The economical yields and the high quality were achieved by applying NK fertilizer at the rate of 100 % combined with foliar application of micronutrient+ biofertilizer inoculation which increased most studied parameters of wheat yield, yield components and grain chemical composition. The beneficial effect of biofertilizer on wheat plants may be due to the important role of biofertilizer in improving N_2-fixing potential and plant growth regulators such as gibberellines, auxins and cytokinines which play an important role in cells division and expansion. Also, it may be due to the effect of increasing of macro and micronutrients availability to plants, which affects plant organs structure. The interaction effect between NK rates, biofertilizer inoculation and micronutrients application increased both wheat yield quantity and quality. The best treatment is applying 100% Nk with biofertilizer + spraying of micronutrients.

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تأثير التلقيح الحيوي ومعدلات من التسميد الآزوتي والبوتاسي و الرش ببعض المغذيات الصغرى على النمو والمحصول و المكونات الكيمائية في نباتات القمح .

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أقيمت تجربة حقلية في قرية المقرنى – ناحية يوسف الصديق بمحافظة الفيوم خلال الموسمين ٢٠٠٨/٢٠٠٩,٢٠٠٩/٢٠١٠ لدراسة تأثير التلقيح الحيوي بالسريالين وثلاثة معدلات من التسميد النيتروجيني والبوتاسي هي ١٠٠,٧٥,٥٠% من المعدل الموصى به للفدان مع الرش الورقي ببعض المغذيات الصغرى (حديد, زنك والمنجنيز) معا وتفاعلاتهم على النمو والمحصول ومكوناته بالإضافة إلى المحتوى الكيميائي و أظهرت النتائج المتحصل عليها ما يلي:

- أدت إضافة معدلات من النيتروجين والبوتاسيوم إلى حدوث زيادة معنوية في صفات النمو (طول النبات- الوزن الطازج والجاف للنبات – محصول الحبوب والقش- وزن ١٠٠٠ حبة بالإضافة إلى تركيز النيتروجين والفوسفور والبوتاسيوم في الحبوب والقش وكذلك المغذيات الصغرى (حديد- زنك- المنجنيز) في الحبة.

- أيضا أوضحت النتائج أن التلقيح الحيوي مع الرش بالمغذيات الصغرى (حديد-زنك-المنجنيز) أعطت أعلى القيم في تركيز النيتروجين والفوسفور والبوتاسيوم في الحبوب والقش ومحتوى العناصر الصغرى فى الحبوب – طول النبات- محتوى الكلورفيل- الوزن الطازج والجاف لكل نبات- محصول الحبوب و القش.

- أعطت التفاعلات بين النيتروجين والبوتاسيوم والتلقيح الحيوي مع الرش ببعض المغذيات الصغرى أعلى القيم لصفات النمو - ومحتوى النيتروجين والفوسفور والبوتاسيوم في الحبوب والقش ومحتوى العناصر الصغرى في الحبوب عند تسميد القمح بمعدل١٠٠% من النيتروجين والبوتاسيوم مع التلقيح الحيوي + الرش بالعناصر الصغرى وكذلك المحصول والقش ومحتوى البروتين في الحبة بينما كانت أقل القيم عند معدل ٥٠% من المعدل الموصى به فقط.

و بصفة عامة فإن أحسن النتائج التي حصل عليها هي تسميد القمح بمعدل ٧٥ أو ١٠٠% من النيتروجين والبوتاسيوم من المعدل الموصى به للفدان مع التلقيح الحيوي والرش ببعض العناصر الصغرى حيث أعطت أعلى القيم للمحصول ومكوناته.