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EFFECT OF SOME FERTILIZERS TREATMENTS ON GIZA 90 COTTON VARIETY

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ABSTRACT: *Two field experiments were carried out at Demo location El-Fayoum Governorate, during the 2008 and 2009 summer seasons to study the effect of some biofertilizers (Cerealin and Phosphorine) and micronutrients alone or combined under the half of the recommended 50% NPK levels (30 kg N + 15 kg P_2O_5 + 12 kg K_2O/fed) (half recommended dose) on leaf macro and micronutrients contents ; plant growth, seed cotton yield and yield components*

The obtained results reveal that:

1- Each of the tested biofertilizer and micronutrients treatments could compensate about half of the NPK need of cotton plant accompanied with a notable yield increase.

2- The balanced fertilization including micronutrients (Fe, Zn and Mn), macronutrients (NPK) and biofertilizer, could increase the NPK fertilizers efficiency , obtaining high seed cotton yield and increase lint percent, plant height, No. of open bolls/ plant and bolls weight.

3- Protein and oil contents in seeds as well as N,P,K,Fe,Zn, and Mn content in seeds were increased by micronutrients and biofertilizers under 50% NPK.

4- The highest cotton seed yield was obtained by full co fertilization with 50% NPK + biofertilizers (Cerealin + Phosphorine) and micronutrients (Fe, Zn and Mn)

5- These clearly confirmed that the biofertilizers treatments could be used under the Egyptian conditions as an effective tool to compensate the quantities of the used chemical fertilizers and consequently reduce the consumption of these fertilizers which in turn minimize the agricultural costs as well as the environmental pollution in Egypt.

Conclusively, it is preferable to fertilizer cotton plants with half chemical fertilization combined with bio-fertilizers (Cerealin + Phosphorine) and micronutrients to achieve the best results of cotton yield, seed yield, seed oil and chemical composition of cotton plant.

Key words: *Cotton, Mineral fertilizers, Biofertilizers, Micronutrients, cotton yield, seed quality.*

INTRODUCTION

Egyptian cotton *Gossypium barbadense* L. is an important cash crop for the, Egyptian farmer and a vital source of raw material for Egyptian textile industry and thus plays an important role in the Egyptian economy. Its contribution to the national income is so great to the extent that we should study all the factors that affect cotton yield in order to maximize the yield per unit area. In addition, Egyptian cotton quality gives us a relative advantage for cotton marketing worldwide.

The heavy use of chemical fertilizers has resulted in serious problems in the soil. It is not only the salinity, but also and more importantly the pollution of the under ground water and the accumulation of chemicals in plant tissue which is a major component of animal fodder and human diet. Also, the misuse of chemical fertilizers disturbed the natural biological balance in the soil.

Recently; biofertilization is used in order to compensate a part of the mineral fertilizer doses, taking in consideration the complementary or synergistic effects of such combination between bio-and mineral fertilization. This could be of economic value from the applied point of view of minimizing the used doses of the mineral fertilizers and consequently reduce agricultural costs as well as soil pollution.

Soil microorganisms known as phosphate solubilizing bacteria play a fundamental role in correcting the solubility problem in many soils, by releasing the fixed form to soluble from to be ready for plant nutrition. The organisms capable of carrying out such process are known as phosphate dissolvers (El-Sheekh, 1997). Microbin, Nitrobein gave the same effect of full nitrogen application which saves about 1/3 of the recommended nitrogen (Bedaiwi *et al.*, 1997).

Cerealin has high amounts of symbiotic and non symbiotic bacteria responsible for atmospheric nitrogen fixation. Its application reduces required mineral nitrogen by 25%, increases the availability of various nutrients, enhances the resistance of plants to root disease and reduces the environmental pollution from chemical fertilizer application (Rizk and Shafeek, 2000).

Micronutrients such as iron, zinc and manganese are commonly applied to several crops and play an important role in the physiological and metabolic processes in cotton plants during different stages of growth. Foliar application of trace elements increased yield of seed cotton production (Bader *et al.*, 1998). Also, micronutrients increase photosynthetic pigments content and enzymes activity in turn enhance plant metabolism which reflected favorably on yield attributes such as number and weight of boll and seed yields/fed of cotton.

The objective of this research was to study the influence of biofertilizers and /or micronutrients in the presence of half dose from mineral fertilizers on cotton plant growth, yield, seed yield and their components as well as chemical composition.

MATERIALS AND METHODS

Two field experiments were conducted at Demo Location –El-Fayoum Governorate, during 2008 and 2009 summer seasons to study the effect of biofertilizers Cerealin and/or Phosphorine with or without micronutrients under 50% NPK levels [30kg N/fed + 15kg P_2O_5 + 12 kg K_2O/fed.(half recommended doses)] compared to the control treatment which was 100% NPK on growth, chemical constituents and productivity of Egyptian cotton cultivar Giza 90(*Gossypium barbadense* L.). The experiments were designed in complete randomized block with three replicates. The plot size was $10.5m^2$ = 1/400 fed.

The studied treatments were:

1- 100% NPK (60kg N + 30kg P_2O_5 + 24 kg K_2O/fed.)
2- 50 % NPK (30kg N + 15kg P_2O_5 + 12 kg K_2O/fed.)
3- 50% NPK + Cerealin
4- 50% NPK + Phosphorine
5- 50% NPK + micronutrients (Fe, Zn and Mn)
6- 50% NPK + Cerealin + Phosphorine
7- 50% NPK + Cerealin + micronutrients
8- 50% NPK + Phosphorine + micronutrients
9- 50% NPK + Cerealin + Phosphorine + micronutrients

Cerealin (a nitrogenous biofertilizer containing a mixture of N_2-fixing bacteria of the genera Azospirillum, Azotobacter, Basicules), Phosphorine (a phosphorus biofertilizer containing phosphate dissolvers or vesicular Arbuscular mycrohizas and silicate bacteria), were supplied by Department of soil Microbiology Soil, Water and Environment Res.Institute Agric. Res. Center.

Nitrogen fertilizer was applied as ammonium sulphate (20.6% N) was side dressed in two equal doses, after thinning one month later. Phosphorus fertilizer was added as superphosphate 15.5% P_2O_5 during soil preparation. potassium was also added as potassium sulphate (48% K_2O) in one dose at time of applying the 1^{st} dose of N.

The plants received three sprays of the mixture of the micronutrients in the EDTA form (Ethylene Diamine Tetra Acetic acid) at the concentration of 1 g Fe-EDTA(6% Fe), 1 g Zn-EDTA (13.5% Zn) and 1 g Mn-EDTA (12%Mn) per liter at the vegetative growth stage (60 days after sowing), at the appearance of the first flower (75 days) and at full flowering stage (95 days after sowing).

Cotton seeds were inoculated with Cerealin (seed coating of one g/100 g cotton seeds) before planting. Arabic gum (0.2%) was used as an adhesive agent. Phosphorine was added to the soil as liquid beside the plant roots after 30 and 60 days after sowing (one L. phosphorine/100 L water/fed). Some physical and chemical properties of the experimental soil were estimated before soil preparation according to procedures outlined by Jackson (1967) and presented in Table (1). Samples of plants were randomly chosen from each plot at 120 days after sowing to determine N, P and K, leaves samples were digested using mixture of H_2SO_4 + $HClO_4$ acids according to Piper (1950). The growth traits were determined as follow:

1- Chemical constituents of cotton leaves at age of 120 days
  1.1. Chlorophyll a,b and total chlorophyll (Arnon, 1949)
  1.2. Nitrogen (A.O.A.C., 1985).
  1.3. Phosphorus (Troug and Mayer,1929)
  1.4. Potassium was determined by flamphotometer (Brown and Lilliand, 1964)
  1.5. Fe, Zn, and Mn were determined according to Chapman and Pratt(1961) using the atomic adsorption spectrophotometer apparatus.

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

Soil properties and units	Value
Particle size distribution (%):	
Coarse sand	7.20
Fine sand	22.95
Silt	16.43
Clay	53.42
Soil textural	Clayey
Soil $CaCO_3$%	9.47
Soil organic matter %	1.82
Soil pH (1:2.5 soil water suspension)	7.94
EC_e (dS/m)	2.81
Soluble ions in soil paste extract (me/L):	
$CO_3^=$	0.00
HCO_3^-	2.04
Cl^-	6.86
$SO_4^=$	19.47
Ca^{+2}	10.2
Mg^{+2}	6.46
Na^+	11.34
K^+	0.37
Available nutrients in soil (mg/kg):	
N	50.75
P	5.7
K	385
Fe	3.25
Mn	0.76
Zn	0.43

2- Some growth characters

No. of branches/plant, No. of leaves/plant, fresh weight of leaves/plant(g), dry weight of leaves /plant (g), fresh weight of stems/plant, dry weight of stem/plant (g), fresh weight of bolls/plant (g) and dry weight of bolls/plant(g) were estimated.

At harvest stage, six plants were chosen randomly from each plot to determine the following traits, (1) plant height (2) number of open bolls/plant, (3) boll weight (g) ,(4) seed cotton yield/plant (g), (5) lint percentage, (6) seed index (100-seed weight)g, and (7) seed cotton yield /fed. (kentar=157.5kg)

Chemical constituents of cotton seeds, this analysis may be listed as follows:

1. Nitrogen, phosphorus, potassium, Fe, Zn, and Mn were determined in seed according to the previous methods
2. Protein content was calculated by multiplying nitrogen by 5.75
3. oil percentage in cotton seeds was determined according to A.O.A.C. (1985) using a Soxhlet apparatus.
4. Oil yield (kg/fed.) was estimated by multiplying oil percentage of seed by seed yield/fed.

The obtained data in the two seasons, 2008 and 2009 were statistically analyzed according to (Snedecor and Cochran,1980).

RESULTS AND DISCUSSION

Growth Characters

Data presented in Table (2) revealed that inoculation of cotton seeds with Cerealin combined with Phosphorine before sowing under 50% mineral fertilization increased all studied vegetative growth characters of cotton plants at age of 120 days. Application of 50 % of mineral fertilizers to inoculated plants with both dual inoculation, i.e. Cerealin + Phosphorine significantly increased number of branches /plant, number of leaves/plant, fresh and dry weights of leaves, stems and bolls as compared to uninoculated cotton plants and exceeds even full NPK fertilization. However, the highest values of these traits resulted from treatment of dual inoculation + 50% NPK + micronutrients. Such results could be explained by the effect of Cerealin in fixing the atmospheric nitrogen beside the role of Phosphorine in supplying the growing plants with available phosphorus, some micronutrients and phytohormones. These results take the same trend with those found by El-Akabawy *et al.*(2000). This means that combination of biofertilizers with suitable dose of mineral fertilizers could help to increase the efficiencies of these fertilizers, saving the environment from the excess mineral fertilization (saving about 50% of chemical fertilizers). The increase in plant growth may be also attributed to the beneficial effects of N on stimulating the meristmatic activity for producing

Table (2): Growth characters of cotton plants at age of 120 days as affected by the studied treatments(g/plant) in mean of 2008 and 2009 seasons

Treatments	No.of branches /plant	No. of leaves /plant	Fresh weight (g/plant)				Dry weight (g/plant)			
			Leaves	Stems	Bolls	Total	Leaves	Stems	Bolls	Total
100% NPK	17.67	43.67	58.01	56.78	150.93	265.72	17.23	18.15	57.93	93.31
50%NPK	13.33	30.67	30.42	26.46	96.01	152.89	11.77	13.28	45.82	70.87
50%NPK + Cerealin	17.33	39.00	49.70	54.03	162.28	266.01	16.12	17.50	59.61	93.23
50%NPK + Phosphorine	15.67	37.67	38.20	42.67	121.39	202.26	12.11	13.60	52.72	78.43
50%NPK + micronutrients	14.67	35.00	40.58	35.13	114.71	190.42	14.13	13.53	50.08	77.74
50%NPK+ Cerealin + Phosphorine	19.67	55.33	77.33	66.59	169.89	313.81	19.67	23.35	65.71	108.73
50%NPK+Cerealin+micronutrients	18.67	45.00	62.73	56.52	164.42	283.67	18.42	22.55	62.31	103.28
50%NPK+phosphorine+micronutrients	16.33	40.00	46.57	48.68	127.96	223.21	16.09	14.60	52.78	83.47
50%NPK+Cerealin+phosphorein+ micronutrients	21.67	59.67	78.31	72.71	175.60	326.44	24.63	27.06	74.27	125.96
L.S.D at 0.05	2.43	3.17	4.38	4.60	5.61	63.31	2.43	2.67	4.11	5.38

more tissues and organs, since N plays major roles in the synthesis of structural protein and other several macro-molecules, in addition to its vital contribution in several biochemical processes that related to plant growth. Moreover, N is essential element for building up protoplasm, amino acids and proteins, which induce cell division, (Marschner, 1995).

Phosphorus is a part of molecular structure of nucleic acid (DNA and RNA), the energy transfer compounds, cell membranes and phosphoproteins, this indicates the great importance of such elements in the physiological processes inside the plant. Moreover, potassium is very important in over all plant metabolism and is involved in the enzymes activities. Also, potassium was found to serve a vital role in photosynthesis and water consumption (Marschner, 1995) .

Microbial inoculants are carrier-based preparations containing beneficial microorganisms which are in available state intended for seed or soil application and designed to improve soil fertility and help plant growth by increasing the number and biological activity of desired microorganisms in the root environment. Plant growth promotion rhizobacteria (biofertilizers) may induce growth promoting directly or indirectly. Direct influences include production of phytohormones , improving the availability and acquisition of nutrients and non-symbiotic nitrogen fixation (Hamdia and El-Komy, 1998) as well as the efficient strains of bacteria that have ability to bring in soluble phosphates in soil into soluble forms (phosphate solubilizing microorganisms) by secretion of organic acids. These acids lower the pH and bring about the dissolution of bound forms of phosphate.

The increase in vegetative growth may be due to the active bacteria in Phosphorine, which is able to transform the tri-calcium phosphate (unavailable form) to mono-calcium phosphate (available form) (Sherif *et al*, 1998).

The present results, in general, are in agreement with those obtained by El-Banna *et al.*(2001) and Kumar *et al.*(2001).

Regarding the effect of micronutrients under study, it could be reported that application of micronutrients combined with Cerealin under 50%NPK was more efficient when compared with micronutrients only or combined with Phosphorine. The beneficial of spraying Fe, Mn and Zn in combinations may be due to the role of these elements on fundamental metabolic reaction and acceleration protein synthesis which affects boll development and formation as reported by Abdel Shafy *et al.*(2001) and hence affects the number of fruiting branches/plant.

Chemical Constituents Of Cotton Leaves at age of 120 days:

a-Effect on photosynthetic pigments in leaves

Results presented in Table (3) show that most treatments under study led to significant increase in chlorophyll content. It seems that these treatments have a good effect on the formation of leaf chlorophyll. The highest value for chlorophyll a,b and total were obtained from plants treated with 50% of recommended NPK/fed.+ dual inoculation + mixed (Fe, Zn and Mn). The enhancing effect of NPK on photosynthetic pigments might be due to that N is a constituent of chlorophyll molecule. Moreover, nitrogen is the main constituent of all the amino acids and hence of proteins and lipids as glactolipids, acting as a structural components of the chloroplasts. Correspondingly , an enhancement of protein synthesis and chloroplasts formation lead to an increase in chlorophyll (Marchner, 1995). These results are in agreement with those obtained by El-Kashlan *et al.*. (1998), Abd El-Shafy *et al.*(2001) and Gebaly (2006).

The effect of inoculation with either Cerealin or Phosphorine or both in presence 50%NPK are showed in Table (3). Data indicated that inoculation with Cerealin or Phosphorine significantly affected photosynthetic pigments as compared to uninoculated plants. Using dual inoculation + 50%NPK significantly affected chlorophyll a,b and total. The superiority of using the bio-compound of Phosphorine +Cerealin compared to any individual treatment may be due to the release of the fixed phosphorus from the soil, and fixing nitrogen, hence increasing the concentration and availability of these two elements (P and N) in the root zone. Phosphorus play a great role in enlargement and cell division as well as the synthesis, division and enlargement of cells as well as it is important for the phytosynthetic processes. Potassium fertilization maintains high productivity and good quality of different crops; Similar results were obtained by Abdel-Shafy *et al.*(2001), Gebaly (2006) and Bishr *et al.*(2007). It is involved in several important metabolic activities associated with photosynthesis, respiration, chlorophyll development and water content of leaves. Other investigators recorded a similar trend on other crops (El-Karamany *et al.*, 2000 and Rizk and Shafeek,2000).

The enhancing effect of micronutrients on the content of photosynthetic pigments of cotton leaves is cleared in Table (3). This could be explained by its beneficial effects on the number of chloroplasts per cell or by forming chloroplasts with a high chlorophyll content(Hassan, 1996). 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. Waly (1996) on pea and Nassar (1997)on wheat.

b-Macronutrients

Data regarding the effect of chemical NPK fertilizer with or without biofertilizer treatments on leaf mineral content are presented in Table (3). Regarding the effect of biofertilizer under 50% NPK, there are significant differences between the treatments in leaf nitrogen, phosphorus and

Table (3): Photosynthetic pigments, macro and micronutrients concentrations in cotton leaves at 120 days after sowing as affected by Bio, Chemical fertilizers and micronutrients in mean of 2008 and 2009 seasons

Treatments	Pigments (mg/g dry weight)			Macronutrients (%)			Micronutrients (mg/kg)		
	Chl.a	Chl. b	Total chlorophyll	N	P	K	Fe	Zn	Mn
100% NPK	4.47	2.38	6.85	3.20	0.27	2.95	316	39	66
50%NPK	3.40	1.96	5.36	2.50	0.23	1.80	300	35	60
50%NPK + Cerealin	4.54	2.46	7.00	2.90	0.25	2.38	328	37	70
50%NPK + Phosphorine	4.19	2.06	6.25	2.80	0.28	2.25	308	36	72
50%NPK + micronutrients	4.31	2.27	6.58	2.65	0.24	1.90	411	44	78
50%NPK + Cerealin + Phosphorine	5.29	2.53	7.82	3.17	0.29	2.65	343	38	75
50%NPK + Cerealin + micronutrients	4.80	2.50	7.30	2.95	0.26	2.45	421	45	77
50%NPK+phosphorine +micronutrients	4.42	2.35	6.77	2.85	0.30	2.40	465	46	80
50%NPK+Cerealin+phosphorine+micronutrients	5.35	2.57	7.92	3.25	0.33	2.75	483	48	85
L.S.D at 0.05	0.07	0.09	0.11	0.11	0.03	0.17	11.54	5.48	7.94

potassium contents, between the treatments. Inoculation with biofertilizers under 50% NPK fertilizer seemed to be the most effective combination.

Generally, it is clear, as shown from the Table (3), that inoculation with Cerealin or Phosphorine under 50% of the recommended dose of NPK gave higher values of N, P and K concentrations than 50 % NPK only. This may result in vigorous growth for cotton plants and the results reflect the positive effect of the interaction between biofertilization and 50%NPK on macronutrients concentration in cotton plants. Dual inoculation with Cerealin and Phosphorine under 50% NPK gave the higher values of nitrogen and phosphorus contents. This positive effect of inoculation upon nutrients concentration could be attributed to high efficiency of bacteria present in the biofertilizer Cerealin to fix atmosphere N and also to the more amount of soluble phosphorus released by bacteria presented in Phosphorine, as well as to produce some biological active substances which help in increasing the root biomass and indirectly help in increasing nutrients concentration in cotton plants. These results are in agreement with those obtained by Hamissa *et al.*,(2000) and Gebaly (2006).

The treatments of 50% mineral fertilizer, combined with biofertilizers plus micronutrients had a great positive effect on NPK concentrations. These results are confirmative to those obtained by Nofal *et al.*(2002) on micronutrient requirement of cotton. In this respect, Abdel Shafy *et al.*(2001) reported that Zn, Fe and Mn sprayed two times at the beginning of flowering stage and 15 days later gave the best effect on chemical constituents of leaves.

c-Micronutrients

Data in Table (3) show the effect of biofertilization under 50% of NPK fertilization on micronutrients concentration in cotton plants. Inoculation of cotton seeds at sowing with the biofertilizers Cerealin and Phosphorine combined with foliar application of micronutrients under 50%NPK increased micronutrients (Fe, Zn and Mn) concentration in cotton plants more than the chemical NPK fertilizer alone, where the highest values were obtained. These results are in agreement with those obtained by Abdel Shafy *et al.* (2001) and Nofal *et al.*(2002). The beneficial effect of biofertilizers on nutrients uptake by cotton plants may be due to its effects on macro and micronutrients availability at the root rhizosphere (Amera and Dahdoh,1997). Also, such behavior may be attributed to the increase in the root absorption surface. These results are in line with the findings of Sabry *et al.*(2000) on wheat plants, and Saleh *et al.*(2000) on maize.

Cotton yield and its components

Data in Table (4) indicate that application of the mineral fertilizers increased the yield of cotton plants and its components. The treatment of 100% mineral fertilizers alone caused significant increases in plant height,

Table (4): Yield and its components as affected by different fertilization treatments under study in mean of 2008 and 2009 seasons

Treatments	Plant height (cm)	Number of open bolls/plant	Boll weight (g)	Lint percentage %	Seed index (g)	Seed cotton yield/plant (g)	Seed cotton yield/fed (kentar*)	Seed cotton yield/fed (Kg)
100% NPK	110	20.33	2.69	39.7	10.6	30.6	9.72	1530.90
50%NPK	103	14.67	2.47	35.5	9.8	23.4	7.51	1182.83
50%NPK + Cerealin	111	19.33	2.66	38.4	10.5	30.0	9.95	1567.13
50%NPK + Phosphorine	107	17.67	2.67	37.8	10.3	29.2	9.82	1546.65
50%NPK + micronutrients	105	16.76	2.64	36.5	10.2	28.4	9.77	1538.78
50%NPK + Cerealin + Phosphorine	116	25.67	2.75	39.5	10.7	34.9	10.90	1716.75
50%NPK+Cerealin + micronutrients	115	23.67	2.69	38.9	10.8	32.9	10.61	1671.08
50%NPK+phosphorine+micronutrients	113	21.67	2.70	38.7	10.6	33.1	10.76	1694.70
50%NPK+Cerealin+phosphorine+ micronutrients	118	27.67	2.77	39.6	10.9	35.5	11.05	1740.38
L.S.D at 0.05	4.27	2.97	0.07	1.29	0.40	1.04	0.27	42 .53

*kentar =157.5 kg

seed cotton yield, and its components i.e. number of open bolls/plant, boll weight (g), lint percentage and seed yield /fed compared to 50% mineral fertilizers alone or combined with Cerealin or phosphorine or micronutrients. This increase was due to that higher level of NPK encourage bolls formation and production. These results are line with those obtained by El-Shahawy and Abd EL-Malik (2000). The beneficial effect of nitrogen addition is due to its role on fundamental metabolic reactions, in addition accelerating protein synthesis which affects boll development and formation. These results are in agreement with those of Abdel-Malak *et al.*(1996) and El-Beilly *et al.*, (2001). The data also indicated that the role of NPK fertilizer is to increase number of open bolls per plants as well as boll weight due to the important role of phosphorus in the physiological processes in cotton plants. Seed cotton yield per feddan was increased significantly with the application of NPK. These results could be attributed with the direct impact of phosphorus on an unlimited number of enzymatic reactions that depend on phosphorylation. Phosphorus is a constituent of the cell nucleus and is essential for cell division and for development of meristematic tissue stimulating the number of buds and bolls/plant. These results showed great similarity to those obtained by Omran *et al.*(1999) and Gamalat *et al* (2000). Also, the beneficial effect of potassium is due to its role for growth and makes the stems often so strong that the plants are readily high and produced more flowers and bolls. These results are in agreement with those obtained by El-Kashlan *et al.*(1998) and Abdel-Shafy *et al.*(2001).

The highest yield and its components were obtained by the treatment of 50% mineral fertilizers combined with the two biofertilizers and micronutrients which led to increases in plant height, number of open bolls/plant, boll weight (g), lint percentage and seed yield/fed. The beneficial effect of biofertilizers, on yield and its components are attributed to the vigorous growth of plants and the amount of metabolites synthesized by the plant and the role of biofertilizers in absorbing nutrients, especially P, Fe, Zn and Mn which play an important role in activation of the metabolic processes. In addition to increasing the amounts of N-fixation by Cerealin. Also, the role of these microorganisms in increasing the N and K-uptake which promote photosynthesis and plant development and consequently the productivity per unit area. These results are in agreement with those obtained by Hamissa *et al.*(2000).

As shown in Table (4), cotton yield and its components were significantly affected by biofertilizers and micronutrients. The treatment 100% NPK alone and treatment 50% NPK + biofertilizers + micronutrients had the greater influence on plant height, number of open bolls per plant, boll weight and seed cotton yield than others. This increase in number of bolls and boll weight might be due to that foliar application of the combination of Zn, Fe and Mn stimulated biological activities, i. e. enzyme activity, chlorophyll synthesis, and rate of translocation of photosynthetic products, but the increase in lint% may be due to the important direct effect of these trace elements on RNA-Synthesis and the following protein formation, which in turn directly affects fiber growth. These results are in agreement with those obtained by El-Kashlan (1995), AbdEl-Shafy (1998), Salem and Mohamed (2000) and Wassel *et al.*(2000).

Chemical constituents of cotton seeds

Data in Table (5) illustrated that combined application of mineral, biofertilizers and micronutrients increased N,P,K,Fe,Zn and Mn concentrations and uptake in cotton seeds. While uninoculated treatments gave the lowest values compared with other treatments.The data revealed that application of 50% chemical NPK + micronutrients along with biofertilizers gave the highest significant increase of macro and micro concentrations and uptake in cotton seeds. This may be due to the stimulating effect of these fertilizers on the plant growth, where the bulk of macro and micro elements are mainly taken up during the vegetative growth stage consequently, increasing the macro and micronutrients uptake which can also occurred as a result of enhancing the metabolic activity of the plant root when mineral nutrients are supplied through the fertilizers application into the soil. The positive effect of Cerealin inoculation upon nutrients uptake could be ascribed to the high efficiency of bacteria present in this biofertilizer to fix atmospheric nitrogen and /or to produce some biologically active substances, e.g. IAA, gibberellin and cytokinine like substances. Such substances would help in increasing the root biomass and thus indirectly help in greater absorption of nutrients from surrounding environment (Saber, 1996 and Awad, 1998) Jagnow *et al.*(1991) reported that Azotobacter and Azospirillum strains produced adequate amount 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.

Also, inoculation with phosphorous dissolving bacteria (PDB) increased significantly of N,P,K,Fe,Zn and Mn concentration and uptake by cotton seeds. These results indicate that inoculation with PDB had more beneficial effects on plant growth and N, P, K, Fe, Zn and Mn nutrition of cotton seeds. Similar results were reported by Saleh *et al.*(2000) and Koreish *et al.*(2001).

Regarding the effect of micronutrients under study, it could be reported that the beneficial effect of spraying Fe, Mn and Zn in combination increased N, P, K, Fe, Mn and Zn concentrations and uptake in cotton seed. These increases may be due to the great efficiency of enzyme activities which affect plant pigments and the rate of photosynthesis (Eid *et al.*, 1997). Another possibility may be the quantitative increase of enzyme responsible for these reactions as a result of more intake and metabolization of nutrients in plants (Nofal *et al.*, 2002). Moreover, increasing growth of cotton plants and its yield indicated the improvement of physiological performance in treated plants due to more nutrients uptake by treated cotton plants from soil.

Table (5): Chemical content of seeds as affected by the treatments under study at 120 days after sowing in mean of 2008 and 2009

Treatments	Macronutrients						Micronutrients						Seed protein (%)	Protein yield (kg/fed.)	Seed oil (%)	Oil yield kg/ fed
	N		P		K		Fe		Zn		Mn					
	Conc. (%)	uptake kg/fed	Conc. (%)	uptake kg/fed	Conc. (%)	uptake kg/fed	Conc. mg/kg	uptake kg/fed	Conc. mg/kg	uptake kg/fed	Conc. mg/kg	uptake kg/fed				
100% NPK	3.2	48.99	0.47	7.20	0.69	10.56	169	0.259	27	0.041	39	0.060	18.40	281.69	20.35	311.54
50%NPK	2.9	34.30	0.40	4.73	0.61	7.22	162	0.192	25	0.030	37	0.044	16.68	197.23	19.75	233.61
50%NPK + Cerealin	3.4	53.28	0.44	6.90	0.67	10.50	177	0.277	30	0.047	44	0.069	19.55	306.36	21.88	342.89
50%NPK + Phosphorine	3.3	51.04	0.46	7.11	0.68	10.52	180	0.278	32	0.049	45	0.070	18.98	293.48	22.70	351.09
50%NPK + micronutrients	3.1	47.70	0.42	6.46	0.65	10.00	191	0.294	33	0.051	50	0.077	17.83	274.28	20.36	313.29
50%NPK + Cerealin + Phosphorine	3.6	61.80	0.48	8.24	0.76	13.05	182	0.312	31	0.053	49	0.084	20.70	355.35	22.82	391.76
50%NPK + Cerealin + micronutrients	3.5	58.49	0.45	7.52	0.70	11.70	187	0.312	34	0.057	48	0.080	20.13	336.32	22.50	375.99
50%NPK+phosphorine+ micronutrients	3.4	57.62	0.47	7.97	0.72	12.20	194	0.329	35	0.059	51	0.086	19.55	331.32	22.73	385.21
50%NPK+Cerealin+ phosphorine+ micronutrients	3.7	64.39	0.49	8.53	0.79	13.75	197	0.343	37	0.064	53	0.092	21.28	370.24	23.70	412.47
L.S.D at 0.05	0.45	7.20	0.03	0.52	0.06	0.92	6.13	0.01	3.75	0.01	5.02	0.01	2.60	41.38	1.38	38.87

Seed protein percentage and yield

Data in Table (5) indicate that seed protein percentage was increased significantly by adding 100% NPK. These results suggest that the 100% NPK application might enhance protein synthesis in the cotton leaves and stimulate the accumulation of protein in the seeds. Seed protein yield/fed was increased significantly by application of biofertilizers as compared to uninoculated. Cerealin or Phosphorine + 50% NPK gave the best result. On the other hand, the mixture of Phosphorine and Cerealin together acted mainly in increasing the availability of phosphorus and nitrogen and consequently increasing their absorption by the plant. It is well known that each of the two elements play a main role in the plant development and production. Nitrogen is present in chlorophyll molecule and components of all proteins. Phosphorus is important for early maturity and for protein and oil production. It functions as a part of the enzyme system having a vital role in the synthesis of other compounds from carbohydrates and is a constituent of nuclear protein. Similar results reported by El-Akabawy *et al.* (2000).

Foliar application of micronutrient fertilizers significantly increased seed protein percentage and yield/fed. This may be due to the important direct role of trace elements on RNA-synthesis and the following protein formation, which in turn affected directly fiber growth. Such results confirmed by Nofal *et al.*, (2002).

Seed oil content and oil yield

Seed content of oil and oil yield reached the maximum when plants received the full recommended NPK (60 +30 +24) kg/fed., 50% NPK + biofertilizers and 50% NPK(30+ 15 + 12 kg/fed.) + biofertilizers (Cerealin + Phosphorine) + micronutrients. Data in Table (5) indicate that the role of NPK fertilization on promoting vegetative growth characters, enhancing yield component parameters and increasing protein yield and oil yield production as well as stimulating the photosynthetic pigments and macro and micro contents of cotton plants. This could be explained by recognizing their fundamental involvement in the very large number of enzymatic reaction that depend on NPK fertilization. NPK effects reflected directly on increasing the content of chlorophyll a and b as well as NPK% content in the leaves were indirectly the cause for enhancing or the augmenting of all other vegetative growth traits yield components and finally protein yield as well as oil yield production of cotton seeds. This result is in good agreement with that obtained by El-Akabawy *et al.*(2000) and Abd El-Kader and Ghaly (2003).

Also, data in Table (5) indicate that biofertilizers lead to significant increase in seed oil and protein percentages and yield/fed. The increase in cotton seed oil and protein content might be due to the promoting effect of these nutrients on the various chemical constituents of the seeds including the oil and protein quantity.

From these results, it could be observed that the foliar application of micro element fertilizers enhanced the growth of cotton plants and finally, improved seed yield and oil yield. Also, from these results generally, it could be recommended to use 50%NPK + biofertilizers + microelement fertilizers to improve the growth, seed and oil yield of cotton plants.

Conclusion

These results clearly confirmed that the biofertilizer treatments could be used under the Egyptian conditions as an effective tool to compensate the quantities of the used chemical fertilizers and consequently reduce the consumption of these fertilizers which in turn minimizing the agricultural costs as well as the Egyptian environmental pollution.

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تأثير بعض المعاملات السمادية على محصول القطن جيزة ٩٠

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الملخص العربي

أقيمت تجربتان حقليتان في منطقة دمو بمحافظة الفيوم خلال موسمي ٢٠٠٨، ٢٠٠٩ لدراسة تأثير استخدام اثنين من المخصبات الحيوية (سيريالين، والفوسفور ين) وكذلك الرش بالعناصر الصغرى (حديد– زنك – منجنيز) تحت نصف المعدل الموصى به من الاسمدة المعدنية (الازوت–الفوسفور–البوتاسيوم) وذلك لتحسين إنتاجية وجودة محصول القطن من ناحية ومن ناحية أخرى خفض معدل السماد المعدني وتقليل النفقات والتلوث البيئي من ناحية أخرى.

وقد أوضحت النتائج المتحصل عليها كما يلي:

١– استخدام الأسمدة الحيوية واستخدام العناصر الصغرى أمكن تعويض حوالى نصف الاحتياجات السمادية المعدنية لمحصول القطن مع زيادة واضحة للمحصول.

٢– التسميد المتوازن المتضمن العناصر الكبرى (ن – فو – بو) والعناصر الصغرى (حديد – زنك – منجنيز) والمخصبات الحيوية عملت على زيادة كفاءة السماد المعدني والحصول على محصول أعلى وزيادة طول النبات وأيضا عدد اللوز المتفتح وزيادة وزن اللوزة.

٣– زيادة نسبة البروتين والزيت في بذور القطن ومحتوى البذور من الفوسفور والبوتاسيوم والعناصر الصغرى نتيجة استخدام نصف معدل (الازوت والفوسفور والبوتاسيوم) والعناصر الصغرى والمخصبات الحيوية.

٤– أعلى محصول من القطن الزهر تم الحصول علية كان فى حالة التسميد المشترك بنصف المعدل الموصى به من (الازوت والفوسفور والبوتاسيوم) مع الأسمدة الحيوية والعناصر الصغرى.

٥– هذه النتائج تؤكد بوضوح مدى فاعلية استخدام الأسمدة الحيوية تحت الظروف المصرية في توفير الأسمدة الكيماوية المضافة مما يؤدى الى تقليل التكاليف الزراعية والتلوث البيئي في مصر.

وبناء على نتائج هذه الدراسة فانه يفضل تسميد نباتات القطن بالمعاملة المختلطة (نصف جرعة التسميد الكيماوي + التسميد الحيوي+ العناصر الصغرى) للحصول على أفضل النتائج وأفضل محصول القطن الزهر ومحصول البذرة والزيت والمحتوى الكيماوي لنباتات القطن.