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EFFECT OF BIO-, ORGANIC-, AND MICRONUTRIENT FERTILIZATION ON YIELD AND MINERAL COMPOSITION OF MAIZE PLANTS GROWN ON CLAYEY AND SANDY SOILS.

BY

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ABSTRACT

The current work was conducted to illustrate the effectiveness of organic manure use to substitute part or all the chemical fertilizers, as well as the biofertilizers and foliar spray of micronutrients effect on maize yield crop production and grain mineral content.

A field experiment was carried out during the growing season of 2004/2005 where maize plants were grown on sandy and clayey soils. Fertilization treatments which were used in these experiments were foliar application with micronutrients, organic manure application, inoculation of maize seeds with Rhizobactrin a composite contains "*Rhizobium leguminosarum*" bacteria, foliar spraying with micronutrients, combinations of them and control.

Results showed significant increase in straw and grain yields of maize plants using the substantial addition of the tested fertilizers when applied individually or together. The highest straw and grain yields were recorded with the treatments of biofertilizers alone or in combination with other fertilizers. Nitrogen and Phosphorus uptake in grains were significantly increased with using all fertilizer treatments, while no significant increase in K content due to such fertilizers treatments was noted except with treatments of organic manure plus biofertilizers and micronutrients plus organic manure. N, P and K contents were increased with adding each one of the tested treatments. Fe, Mn and Zn uptake in both grains and straw increased by fertilizers application. The increase was slight when the mineral source of them was applied alone, the Fe, Mn and Zn uptake and contents increased markedly when the mineral micronutrients were combined with biofertilizer or with bio. and organic fertilizers.

INTRODUCTION

Maize is one of the most important grain crops grown in Egypt. There is an ever increasing need to increase the agricultural production in Egypt to meet the continuously increasing demands of the growing population. So increasing the total cultivated area of maize in sandy soils is one of the important targets.

To increase the maize production, it is fundamentally necessary to pay particular attention to the nutrient supply to this crop, since, maize proved very responsive to various nutrients.

The use of N fixing bacteria as biofertilizers (bio.) can reduce the use of chemical fertilizer, decrease environmental pollution. Thus, many investigators have used biofirtilizers successfully to minimize the dependence on chemical fertilizers (Ishac, 1998, Saber *et al.*, 1989, Omer *et al.*, 1991, Monged *et al.*, 1996 and El-Akabawy *et al.*, 2001).

Lately, attention has been increasingly focused on the impact of chemical fertilizers on the environment. This has caused a renewed interest in the use of organic manure to supply part or all plant nutrients to maize (Saleh and Abd El-Fattah, 1997). The status of essential nutrients and soil microbial activity could be affected by organic manures addition (El-Emam, 1999), similar findings were reported by El-Akabawy *et al.* (2001).

Foliar application of micronutrients for most crops took the priority and popularity in correcting micronutrients deficiencies in Egypt for as long four decades ago with a great deal of effectiveness (Amin *et al.*, 1998). However, foliar application of micronutrients can only give high yield increase when the crop needs of the major elements are satisfied (El-Fouly, 1983 and El-Akabawy *et al.*, 2001).

The current investigation was conducted to study the effectiveness of organic manure, bio. and micronutrient on nutrients availability and the impact on crop yield and nutrient status in straw and grains of the crop.

MATERIALS AND METHODS

A field experiment was carried out in two locations during the growing season of 2004/2005, where maize plants (*Zea mays* cv SWC 10) was grown on sandy (1st location) and clayey (2nd location) soils. The sandy soil was in a location in Ismailia Agriculture Station and the clayey soil was in an experimental farm of the Agriculture Research Center, Giza, Egypt. Physical and chemical properties of the two soils were determined according to the standard procedures described by Black (1965) and shown in Table (1). The experimental design was a randomized complete block (factorial) with three replicates. Factors of the study were: (1) Soil and (2) Fertilization; soil factor involved clayey soil and sandy soil. Fertilization factor involved the following 5 treatments: 1) **C** [control, with no fertilization] 2) **M** [foliar application using a solution of 500 mg Fe + 500 mg Mn + 500 mg Zn/L, all micronutrients were in sulphate form, foliar spraying was applied two times; the first was 30 days after sowing, the second was 25 days after the first one. Rate of spray was 200 L/fed in each time] 3) **O** [organic manure application; organic manure was in form of chicken manure and was applied at a rate of 3 Mg/fed (1 Mg "mega gram" = 10^6 g); chemical analysis of chicken manure was as follows: organic matter% = 43.45, total C% = 25.15, total N% = 2.14, total P% = 1.55 and total K% = 2.08. Available N, P and K = 1088, 1552 and 1780 mg/kg, respectively. pH (1:5) = 8.23 and EC (1:5) = 8.46 dsm^{-1}]. 4) Bi: biological inoculation; [before planting, maize seeds were inoculated with biofirtilizer (Rhizobactrin, a composite contains "*Rhizobium leguminosarum* bv Viceae" through mixing seeds with appropriate amount of them at rate of 300g/40 kg maize seeds]. 5) M+O 6) M+Bi 7) O+Bi and 8) M+O+Bi.

Table (1): The Physical and chemical properties of the experimental soils.

Property	Value	
	Clayey soil	Sandy soil
Sand, %	30.56	92.12
Silt, %	14.14	2.40
Clay, %	55.30	5.48
Textural class	Clay	Sand
pH*	8.25	8.15
EC* dSm^{-1}	1.41	1.09
O.M, %	2.83	0.24
$CaCO_3$ %	2.71	1.47
Soluble cations, $mmol_c/L$		
Ca^{++}	5.07	4.56
Mg^{++}	2.47	2.60
Na^{+}	5.34	3.07
K^{+}	1.08	0.36
Soluble anions, $mmol_c/L$		
CO_3^{--}	0.00	0.00
HCO_3^{-}	3.11	2.60
Cl^{-}	5.35	5.83
$SO4^{--}$	5.50	2.16
Available nutrients, mg kg^{-1}		
N**	56.20	24.77
P**	11.10	4.10
K**	685.00	68.20
Fe**	10.22	2.92
Mn**	4.14	0.87
Zn**	1.35	0.58

* 1:2.5 soil suspention (for pH) and saturated extract (for EC).

** N (KCl extract); P (Na bicarbonate extract); K (NH_4-Acetata extract) and other (DTPA extract).

A basal dose of urea, calcium super phosphate and potassium sulphate was added to each plot before sowing at a rates of 120 kg N, 12.8 kg P and 20 kg K/fed. After 65 days of sowing plant samples were collected weighed, dried at 70°C, ground, digested in H_2SO_4 and $HClO_4$ mixture and content of N, P, K, Fe, Mn and Zn were determined after maturity, plants were harvested, the yields of grains and straw were recorded. Portion of dry plant samples were ground for nutrient analysis. Ground material was digested in mixture of concentrated H_2SO_4 and $HClO_4$ acids and N, P, K, Fe, Mn and Zn were analysed: Total N was determined using the micro Kjeldahl method, P was measured in plant digests using ammonium molybdate and ascorbic acid (Watanabe and Olsen, 1965) and K was measured using the Flame Photometer. Fe, Mn and Zn were measured using Atomic Absorption Spectrophotometer, (Perkin Elmer 3110). All data were statistically analyzed according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Data of table (2) reveal that dry matter weigh/plant of maize plants of 65 days growth was significantly increased with the single combined application of bio., organic and micronutrients. The clayey soil produced higher dry weight per plant as compared with the sandy soil. The highest dry matter yield (378.48 g/plant) was recorded with the (M+O+Bi) treatment in which, micronutrients, bio. and organic fertilizers were combined together.

The highest increase percentage of 68.70 was achieved with the (M+O+Bi) treatment for maize plants grown on the sandy soil. The lowest increase percentage of 8.50 was recorded with M treatment which received N,P,K and micronutrients only.

The superiority of the clayey soil over the sandy one reflects the higher natural fertility of clayey soils over sandy soils .

Organic fertilization caused a positive enhancement on dry weight of plants grown on both soils. A similar trend was obtained with biofertilization. Combined application of organic and biofertilizers significantly increased dry matter yield of maize plants. Their positive effect indicates the high content of the available macro and micro-nutrients through new addition of nutrients from their decomposition, especially with organic fertilizers.

These results are in harmony with these reported by Faisal and Shalaby (1998), El-Akabawy *et al.*, (2001) and Massoud *et al.*, (2004) who stated that inoculation wheat seeds with Azospirillum increased significantly dry matter yield of wheat straw after 50 days of sowing by 20.2%.

Nitrogen uptake by maize plants after 65 days of sowing was significantly increased with all of the studied treatments except that of micronutrients when the increase was slight (Table 2). The highest N uptake obtained by (M+O+Bi) was induced with using the combination of micro, organic and biofertilizers. The lowest N uptake was recorded with the (M) treatment which received micronutrients only. Such effect was more pronounced in the sandy soil. Combining organic or biofertilization with micronutrients significantly increased N uptake by the growing plants of both soils. This may be due to increasing N availability which in turn enhances N uptake. The obtained results are similar to those reported by Alfoldi *et al.*, (1994), El-Habbak and Shams El-Din (1996), El-Ghozoli (1998), El-Emam (1999), El-Fiki (2000) and Massoud *et al.*, (2004) who stated that inoculation of wheat grains with Azospirillum increased N content in dry matter yield of wheat plants after 50 days of sowing..

Data of Table (2) reveal significant differences in P uptake among treatments of fertilization, and between the tested soils. Phosphorus uptake by maize plants grown on both soils was increased with using organic and /or biofertilization beside using Fe, Zn, Mn and Cu. The highest value of P uptake (1.26 g/plant) was found with (M+O+Bi) treatment, while the lowest value (0.68 g/plant) was associated with the M treatment of sandy soil. Generally, P uptake by maize plants grown on clayey soil was higher than that of plants grown on sandy soil. The highest increase percentage was accompanied with (M+O+Bi) treatment for plants grown on sandy soil, while the lowest value was recorded with (M) treatment for the same soil. Data of table (2) reveal valuable increases in P uptake percentage in case of plants grown on sandy soil as compared with clayey one.

These results agree with those of Dahiya and Singh (1980), Dahiya *et al.*, (1987), El-Koumey *et al.*, (1998) and El-Kallawy (2002) who found that addition of organic manure, micro and macronutrients to alluvial and calcareous soils increased N, P, K, Zn and Fe concentration and uptake by corn plants.

Using either organic fertilization or biofertilization increased P uptake by maize plants grown on both soils.

Potassium uptake by maize plants grown on both soils was significantly increased with using (O+Bi) treatments (Table 2). The response of maize plants to fertilization treatments was more pronounced in the sandy soil as compared with clayey one. In case of the clayey soil, no significant differences were noticed in K uptake by maize plants receiving fertilizer treatments from (M) to (M+O). However, plants grown on the sandy soil revealed significant differences in their K uptake among the tested treatments. This reflects the poverty of sandy soils in potassium. Generally, K uptake was higher in plants grown on the clayey soil as compared with those of sandy soil.

The obtained results agree with those reported by Soliman (1982), Nour El-Dein (1996), Abou-Hussien (1997) and Massoud *et al.*, (2004) who stated that inoculation of wheat grains with Azospirillum increased K contents in dry matter yield of wheat plants after 50 days of sowing..

The highest values of K uptake were found in plants which received the (M+O+Bi) treatment which were grown on the clayey soil (7.98 g/plant) and sandy soil (6.24 g/plant). The highest increase (56.40%) in K uptake was recorded with the (M+O+Bi) treatment for plants grown on the sandy soil, while the lowest increase (6.50%) was found in plants grown on sandy soil and received the (O) treatment.

Data of Table (2) show that Fe uptake by maize plants was significantly increased with all of fertilization treatments. The clayey soil revealed higher Fe uptake as compared with the sandy soil. Treatments having micronutrients alone or combined with organic and/or biofertilization showed higher Fe uptake as compared with those of the control or which did not receive micronutrients.

Table (2): Effect of bio-, organic-, and micronutrient fertilization on dry weight and uptake of macro and micronutrients by maize plants grown in clayey and sandy soils at 65 days after sowing.

Soil** (S)	Fertilization* (F)								Mean
	C	M	O	Bi	M+O	M+Bi	O+Bi	M+O+Bi	
	Dry weight (g/plant)								
S1	246.02	265.19	319.15	311.44	361.20	370.93	368.60	378.48	327.63
S2	207.40	224.98	283.24	280.16	303.79	322.82	332.06	349.81	288.03
Mean	226.71	245.09	301.20	295.80	332.50	346.88	350.33	364.15	
L.S.D 0.05	F = 12.00		S= 6.00		FxS= NS				
	N uptake (g/plant)								
S1	10.00	10.25	10.44	10.34	11.16	11.35	11.74	11.83	10.87
S2	7.50	7.55	8.71	8.99	11.64	11.59	11.98	11.98	10.00
Mean	8.75	8.90	9.57	9.67	11.40	11.50	11.88	11.93	
L.S.D 0.05	F=0.34		S= 0.14		FxS= 0.48				
	P uptake (g/plant)								
S1	0.96	1.00	1.04	1.02	1.04	1.13	1.24	1.26	1.09
S2	0.68	0.68	0.75	0.85	0.96	1.02	1.07	1.09	0.89
Mean	0.81	0.85	0.89	0.94	1.00	1.07	1.15	1.17	
L.S.D 0.05	F= 0.04		S= 0.02		FxS= 0.06				
	K uptake (g/plant)								
S1	6.47	6.47	7.06	7.19	7.21	7.34	7.63	7.98	7.17
S2	3.99	4.26	4.25	5.62	4.92	4.97	5.98	6.24	5.03
Mean	5.23	5.37	5.64	6.38	6.08	6.16	6.80	7.11	
L.S.D 0.05	F= 0.43		S= 0.20		FxS= NS				
	Fe uptake (mg/plant)								
S1	12.03	13.37	13.22	13.60	13.50	15.44	15.11	15.94	14.02
S2	10.96	11.95	11.08	12.28	11.53	13.47	12.90	13.99	12.28
Mean	11.48	12.67	12.20	12.95	12.50	14.47	14.02	14.96	
L.S.D 0.05	F= 0.45		S= 0.22		FxS= NS				
	Mn uptake (mg/plant)								
S1	5.76	6.69	5.88	7.18	7.24	9.53	7.92	9.66	7.49
S2	4.83	5.39	5.57	6.13	6.00	7.12	6.69	7.80	6.19
Mean	5.26	6.07	5.76	6.69	6.62	8.36	7.30	8.73	
L.S.D 0.05	F= 0.43		S= 0.19		FxS= 0.62				
	Zn uptake (mg/plant)								
S1	11.64	12.16	11.68	13.04	11.96	13.32	13.40	14.88	12.76
S2	10.72	11.08	11.12	12.04	11.28	12.20	11.88	12.76	11.64
Mean	11.20	11.64	11.40	12.56	11.64	12.80	12.64	13.84	
L.S.D 0.05	F = 0.48		S= 0.24		FxS= 0.64				

* C: control (no fertilization). M: micronutrients foliar application. O: organic manure application. Bi: inoculation with biofertilizer

** S1: clayey soil. S2: sandy soil.

The highest Fe uptake value (15.94 mg /plant) was found in plants which received (M+O+Bi) treatment and grown on clayey soil, while the lowest value of (10.96 mg/plant) was found in the control treatment for plants grown on the sandy soil. The highest increase in Fe uptake (32.50%) resulted from using the (M+O+Bi) treatment with clayey soil, while the lowest increase (1.10%) was accompanied the (O) treatment for plants grown on the sandy soil.

In cases of nutrient uptake there were interactions between fertilizer treatments and soil was significant. This is shown when the fertilization treatment were much more pronounced under conditions of the sandy soil

A gradual and steady increases in Mn uptake by maize plants grown on clayey soil occurred except those of plants treated with (O) and (O+Bi) treatments (Table 2). The highest increase in Mn uptake was observed with using a combined treatment having all of the tested fertilizers (micro-, organic, and bio). Addition of Mn with other micronutrients in mineral form significantly increased Mn uptake as compared with control treatment. Using the organic fertilizer (O treatment) decreased Mn uptake, while using bio-fertilizers significantly increased Mn uptake either when added alone or in combination with other types of fertilizers (micro, organic and bio). Worthy to note that the biofertilizer, showed the highest positive effect on Mn uptake. This may be attributed to the higher ability of rhizobium to solubilize Mn in soil.

Similar trend was observed with sandy soil with a significant and gradual increase in Mn uptake with using the tested treatments with an emphasis on the superiority of bio-fertilizer as compared with other treatments. Generally, plants grown on the sandy soil produced plants with lower Mn uptake as compared with, those grown on clayey soil. The superiority of clayey soil reflects its high content of Mn. These results agree well with those of El-Emam (1999) and El-Fiki (2000). The inferiority of organic fertilizer may be due to its high content of chelating agents e.g. organic compounds which bond Mn temporarily in unavailable form and may be due to the immobilization of Mn by microorganisms.

Znic uptake by maize plants grown on clayey and sandy soils showed similar trend to that obtained with Mn (Table, 2). Positive effects of the added micronutrients and biofertilizer were noticed when each of them was added alone or in combination with the other. Plants grown on the clayey soil took up more Zn than those taken up by plants grown on the sandy soil.

Data of Table (3) show the effect of micronutrients, organic and biofertilization on dry matter yield of straw and grain of maize plants. Straw yield of plants grown on both soils was increased with the addition of the tested fertilizers when applied individually or together.

The highest straw yield was recorded with the (M+O+Bi) treatment especially when applied to clayey soil. Significant increases in dry matter yield of straw of plants grown on clayey soil under each treatment were noticed as compared with corresponding ones of plants grown on sandy soil. These results support the results of El-Fiki (1994), El-Koumey (1998), El-Shafie (1999), El-Kallawy (2002) and Massoud *et al*., (2004).

Regarding the effect applying micronutrients the highest positive effect of treatments on grain production occurred with biofertilizers applied alone or in combination with other fertilizers. The low response to the organic fertilizer as combined with other fertilizers may be due to its fast decomposition and short lasting positive effect as it was effective after 65 days and less effective after harvest. These results agree well with those of Hamissa *et al.*, (1991), El-Emam (1999), Schlegel and Bond (2001) and El-Akabawy (2001) found that organic manure and foliar spray with micronutrients resulted in increases in corn yield.

Table (3): Effect of bio-, organic-, and micronutrient fertilization on straw and grain yield, grain weight per ear and 100 grain weight of maize plants grown in clayey and sandy soils.

Soil** (S)	Fertilization* (F)								Mean
	C	M	O	Bi	M+O	M+Bi	O+Bi	M+O+Bi	
	Straw yield (ton/fed)								
S1	4.47	4.64	4.66	4.64	4.97	5.02	5.10	5.26	4.85
S2	3.80	4.10	3.89	4.40	4.30	4.66	4.84	4.72	4.34
Mean	4.14	4.37	4.28	4.52	4.64	4.84	4.97	4.99	
L.S.D 0.05		F = 0.20		S= .010		FxS= NS			
	Grain yield (ton/fed)								
S1	3.29	3.36	3.36	3.43	3.58	3.61	3.67	3.67	3.60
S2	3.15	3.23	3.26	3.25	3.40	3.43	3.53	3.56	3.35
Mean	3.22	3.29	3.31	3.34	3.49	3.52	3.60	3.61	
L.S.D 0.05		F= 0.08		S= 0.04		FxS= NS			
	Grain weight /ear (g)								
S1	243.91	243.99	243.92	244.83	246.98	250.04	250.36	249.75	246.72
S2	233.25	234.23	234.23	236.53	242.12	246.19	247.23	248.22	240.25
Mean	238.58	239.11	239.08	240.68	244.55	248.12	248.80	248.99	
L.S.D 0.05		F= 3.25		S = 1.61		FxS= 4.61			
	Weight of 100 grain (g)								
S1	35.59	35.63	35.60	35.93	36.52	36.98	37.10	37.60	36.37
S2	34.10	34.51	34.26	34.86	35.46	35.43	35.75	36.07	35.10
Mean	34.84	35.07	34.93	35.40	35.99	36.21	36.42	36.82	
L.S.D 0.05		F= 0.58		S= 0.29		FxS= NS			

See footnote of Table (2).

Grain weight/ear was increased with using each fertilizer alone and further significant increases were observed with the combinations having biofertilizer especially when added to the clayey soil. In case of the sandy soil, there was also a positive significant increase with biofertilizers alone and the combinations of the tested fertilizers. The superiority of the clayey soil over the sandy one reflect its higher fertility. Plants grown on the sandy soil revealed more response to the applied treatments as the increase percentages were higher than the corresponding those of clayey soil. This result reflects the lack of nutrients and poverty of sandy soil.

Results of the 100-grain weight presented in Table (3) reflect the effect of fertilizer treatments and soil. Positive and significant increases in the 100-grain weight were achieved with using the combinations between every two fertilizers beside the treatment having all of the tested fertilizers. It means that organic or biofertilizer was more effective in the presence of micronutrients or both of them. The clayey soil produced plants with higher weight of 100-grain compared with the sandy soil. Thus, the obtained results indicate the beneficial effect of bio and/or organic fertilizers. This biofertilizer effect could be lasting for long time and provide plants with the needed nutrients such as N during the growing season.

Nitrogen and phosphorus contents in grains were significantly increased with using all fertilizer treatments, while no significant increase in K content due to such fertilizer treatments was noticed except with treatments of the organic + the biofertilizer and the micronutrients + the organic fertilizer (Table 4). Contents of N, P and K in grains of plants grown on the clayey soil were significantly higher than those of plants grown on sandy soil. The increase percentages of N, P and K contents in grains were most pronounced with the sandy soil.

The highest increase percentages of N were 20.10, 23.25 and 17.20% resulted from applying (O+Bi) and(M+O+Bi) to sandy soil and (M+O+Bi) to clayey soil, respectively.

In case of P, the highest increase percentages were recorded with (M+O) and (M+Bi) in the sandy soil and (O+Bi) and (M+O+Bi) in the clayey soil. The increase of P in grains of plants grown on sandy soil was high and reached about 90%, while the corresponding increase in clayey soil was 19.44% Increasing P in grains of plants grown on sandy soil due to the treatments may reflect the lake of initial P in sandy soil. Similar trend was observed with K concentration in grains of plants grown on sandy and clayey soil.

These results support the results of El-Aggory *et al.*, (1996), El-Rabie *et al.*, (1997), El-Emam, (1999), El-Fiki, (2000), El-Akabawy *et al.*, (2001) and Massoud *et al.*, (2004) who found that inoculation with Rhizobium increased N, P and K contents in seeds and straw of pea.

Concerning nitrogen content in straw, it was increased with adding each one of the tested treatments. Generally, nitrogen values in straw were lower than those of grains, the clayey soil provided more nitrogen to the growing plants as compared with the sandy soil. Similar results to those of N was noticed with P and K content. The most effective treatments in case of P and K were (O+Bi) in the clayey soil and (M+O+Bi) in the sandy soils. In general, straw of plants grown on the sandy soil showed higher values of N, P and K contents as compared with those obtained with the clayey soil. This reflects the poverty of sandy soil.

Data of Table (5) reveal that the concentrations of Fe, Mn and Zn in both grains and straw recorded the lowest values when the mineral source of them was applied alone. It means that the mineral form was less available when added to the soil or less effective when sprayed on leaves. Contents of Fe, Mn and Zn were enhanced (in grains as will as in straw) when mineral micronutrients were combined with biofertilizer or with bio and organic fertilizers. The positive effect of such fertilizers may be due to their ability to chelate micronutrients in case of organic and the positive role played by microorganisms, in case of biofertilizer, as they produce amino acids which enhance micronutrients uptake such as Fe, Mn and Zn.

Table (4): Effect of bio-, organic-, and micronutrient fertilization on macronutrients content in grains and straw of maize plants grown in clayey and sandy soils.

Soil** (S)	Fertilization* (F)								Mean
	C	M	O	Bi	M+O	M+Bi	O+Bi	M+O+Bi	
	N content in grains (%)								
S1	2.312	2.379	2.564	2.501	2.571	2.564	2.698	2.709	2.538
S2	1.917	2.001	2.120	2.074	2.241	2.265	2.302	2.363	2.160
Mean	2.114	2.181	2.335	2.287	2.406	2.414	2.500	2.528	
L.S.D 0.05		F= 0.017		S= 0.005		FxS= 0.020			
	P content in grains (%)								
S1	0.360	0.370	0.390	0.370	0.400	0.380	0.430	0.420	0.390
S2	0.200	0.320	0.350	0.330	0.380	0.380	0.360	0.370	0.340
Mean	0.280	0.350	0.370	0.350	0.390	0.380	0.390	0.390	
L.S.D 0.05		F = 0.020		S= 0.010		FxS= 0.040			
	K content in grains (%)								
S1	1.252	1.377	1.283	1.315	1.440	1.471	1.440	1.283	1.346
S2	0.720	0.720	0.751	0.783	0.908	0.845	0.970	0.939	0.845
Mean	1.002	1.064	1.033	1.064	1.189	1.158	1.221	1.127	
L.S.D 0.05		F= 0.188		S= 0.094		FxS=0.282			
	N content in straw (%)								
S1	2.732	2.761	2.851	2.798	3.027	2.948	3.230	3.042	2.923
S2	1.606	1.671	1.978	2.019	2.141	2.069	2.329	2.229	2.006
Mean	2.169	2.232	2.413	2.426	2.585	2.507	2.764	2.635	
L.S.D 0.05		F = 0.019		S= 0.006		FxS= 0.022			
	P content in straw (%)								
S1	0.180	0.180	0.230	0.200	0.240	0.210	0.260	0.260	0.220
S2	0.130	0.130	0.150	0.130	0.160	0.160	0.180	0.180	0.150
Mean	0.160	0.160	0.190	0.170	0.200	0.190	0.220	0.220	
L.S.D 0.05		F= 0.020		S= 0.010		FxS= 0.040			
	K content in straw (%)								
S1	1.937	1.921	2.092	2.108	2.222	2.263	2.580	2.369	2.190
S2	0.912	0.993	1.099	1.188	1.368	1.425	1.514	1.726	1.278
Mean	1.425	1.498	1.595	1.693	1.832	1.848	2.092	2.043	
L.S.D 0.05		F= 0.049		S = 0.024		FxS= 0.057			

See footnote of Table (2).

Table (5): Effect of bio-, organic-, and micronutrient fertilization on micronutrients content in grains and straw of maize plants grown in clayey and sandy soils.

Soil** (S)	Fertilization* (F)								Mean
	C	M	O	Bi	M+O	M+Bi	O+Bi	M+O+Bi	
	Fe content in grains (mg kg^{-1})								
S1	203.03	211.22	211.55	227.83	234.20	253.22	222.26	256.30	227.45
S2	140.68	159.49	147.75	158.32	158.15	169.94	158.62	179.17	159.01
Mean	171.86	185.36	179.65	193.08	196.18	211.58	190.44	217.74	
L.S.D 0.05		F = 7.54		S= 3.81			FxS= NS		
	Mn content in grains (mg kg^{-1})								
S1	173.31	178.72	174.47	182.23	178.53	213.08	196.63	203.18	187.52
S2	136.61	146.08	137.57	149.78	139.16	178.47	142.36	172.26	150.28
Mean	154.96	162.40	156.02	166.01	158.85	195.78	169.50	187.72	
L.S.D 0.05		F = 2.89		S= 1.50			FxS= NS		
	Zn content in grains (mg kg^{-1})								
S1	80.54	86.57	84.29	89.19	91.80	109.47	96.76	105.71	93.05
S2	58.63	69.04	61.78	66.30	68.62	79.20	73.47	82.42	69.94
Mean	69.59	77.82	73.04	77.75	80.21	94.34	85.12	94.07	
L.S.D 0.05		F = 1.26		S= 0.63			FxS= NS		
	Fe content in straw (mg kg^{-1})								
S1	195.41	195.69	196.16	196.16	197.26	212.33	196.45	202.47	198.99
S2	154.19	158.84	154.48	156.51	158.01	165.44	158.71	169.95	159.52
Mean	174.80	177.26	175.32	176.33	177.63	188.89	177.58	186.21	
L.S.D 0.05		F = 1.23		S = 0.61			FxS= 1.44		
	Mn content in straw (mg kg^{-1})								
S1	147.83	152.25	148.15	148.83	149.02	154.85	149.33	153.07	150.42
S2	89.41	101.00	90.65	96.05	96.47	107.94	95.58	109.47	98.32
Mean	118.62	126.63	119.40	122.44	122.75	131.40	122.50	131.27	
L.S.D 0.05		F= 1.60		S = 0.81			FxS= 2.25		
	Zn content in straw (mg kg^{-1})								
S1	77.82	83.59	78.96	78.90	87.35	94.46	85.16	91.05	84.67
S2	42.08	46.13	43.51	48.88	45.31	55.01	51.65	56.37	48.62
Mean	59.96	64.85	61.23	63.88	66.33	74.74	68.41	73.71	
L.S.D 0.05		F= 0.08		S= 0.04			FxS=0.13		

See footnote of Table (2).

These results agree with those of Badr *et al.*, (1991), El-Rabie *et al.*, (1997), Fawzi *et al.*, (2000), El-Akabawy *et al.*, (2001) and Salem *et al.*, (2005) who stated that application organic manure and foliar application of Zn resulted in increase in macro and micronutrients content in both straw and seeds yields of faba bean.

Plants grown on the clayey soil produced grains and straw of higher Fe, Mn and Zn contents as compared with those grown on the sandy soil. Values of Fe, Mn and Zn in straw were lower than the corresponding ones in grains.

These results agree with those of Abdel-Aziz *et al.*, (1986), Abou Hussien and Faiyed (1996), El-Fiki (2000) and El-Kallawy (2002) who found that Fe, Mn and Zn uptake by corn plants was obviously higher on alluvial soil than those on calcareous one.

The current investigation showed the importance of organic and biofertilization as well as adding micronutrients to maize plants grown on sandy soil in particular and clayey soil in general. Organic, bio, and micronutrients possess a positive effect on all the tested plant parameters. The tested treatments increased all plant parameters by different proportions in both soils which reflects the importance of raising the fertility of soils particularly of the sandy soils.

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تأثير التسميد الحيوى والعضوى وبالعناصر الصغرى على المحصول والتركيب المعدنى لنباتات الذرة منزرعة فى أراضى طينية ورملية.

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أجريت هذه التجربة لإستبيان تأثير إستخدام التسميد الحيوى والعضوى والرش بالعناصر الصغرى على محصول نبات الذرة والمحتوى المعدنى للحبوب. ولتحقيق هذا الهدف تم إجراء تجربة حقلية خلال موسم ٢٠٠٥/٢٠٠٤ حيث زرعت نباتات الذرة فى أرضين أحداهما طينية والأخرى رملية وكانت معاملات التسميد المستخدمة هى: حيوى (تلقيح حبوب الذرة بالريزوبكترين)، عضوى (مخلفات دواجن بمعدل ٣ طن/ فدان) والرش بالعناصر الصغرى (الحديد، المنجنيز، الزنك). ولقد أوضحت النتائج أن هناك زيادة معنوية فى محصولى القش والحبوب لنباتات الذرة عند أستخدام المعاملات السابقة منفردة أومشتركة مع بعضها وكان أفضل القيم المتحصل عليها لمحصولى القش أوالحبوب عند إستخدام الأسمدة الحيوية منفردة أومشتركة مع أى معاملة أخرى. كما زاد محتوى الحبوب من النتروجين والفوسفور بدرجة معنوية مع كل المعاملات، بينما زاد البوتاسيوم فقط مع معاملات (التسميد الحيوى + العضوى) أو(العضوى + رش عناصر صغرى) وقد سجلت تركيزات النتروجين والفوسفور والبوتاسيوم فى محصول القش أعلى القيم مع معظم المعاملات تحت الدراسة. أما تركيزات الحديد والمنجنيز والزنك فى محصولى القش والحبوب أخذت فى الزيادة عند إستخدام التسميد العضوى أوالحيوى بالإضافة للرش المعدنى.