EFFECT OF FOLIAR OR SOIL APPLICATION OF SOME MINERAL AND CHELATED MICRONUTRIENT FORMS ON THE YIELD AND ITS COMPONENTS OF PEANUT AND MAIZE GROWN ON SANDY SOIL

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ABSTRACT:

Two field experiments were conducted on a sandy soil cultivated with two summer crops, *i.e*., peanut (Giza 5) and maize (Giza 2) under sprinkler irrigation system during growing season of 2004 at Ismailia Agric. Res. Station. The current work aimed to evaluate impact of micronutrients in two forms, i.e., mineral (Fe, Mn & Zn sulphates) and chelating compounds (Fe, Mn & Zn-amino acids, -citrate, -EDTA and -legnosulphate), added as foliar and soil application, on yield and its components for each of the studied crops as well as peanut seed and maize grain contents of some nutrients (N, P, K, Fe, Mn and Zn). Also, this study takes in consideration the residual effect of the two application methods on available micronutrients status in soil.

The result obtained reveal that peanut and maize yields and their components showed, in general, a markedly response to all applied treatments, with a superior effect for foliar spray but insignificant differences with soil application, as shown in a descending order according to their effective roles: amino acids > citrate > sulphates > EDTA > legnosulphate. The chelating compounds of amino acids and citrate recorded the superior increases in both peanut and maize for protein content and 100 peanut seed or maize grain weights, while an inferiority effect was observed with legnosulphate. Both forms of EDTA and sulphates were lying in between. The superior effect of amino acids may be due to their more adhesion for chelating micronutrients, and enhancing their absorption and transportation inside the plant in easier status. Moreover, amino acids as micronutrient compounds are found in smaller molecules that are more suitable for cell membrane permeability.

There were positive effects for the tested treatments, with exception of legnosulphonate, on micronutrient contents in peanut seed and foliage or maize grain and stover, with superiority for amino acids and citrate as micronutrient compounds. For the residual effect of the applied treatments on soil available micronutrient contents, data show a markedly increase in the case of soil application as compared to foliar spray, in spite of an insignificant differences between micronutrients uptake by the grown plants in both tested methods.

From aforementioned results, it can be concluded that, the application of micronutrients either in mineral sulphates or chelating compounds under both foliar spray and soil application increased crop yields and their components as well as improved the nutritional status of both peanut and maize plants grown on a sandy soil under sprinkler irrigation system, with relatively higher ability for increasing available micronutrients in soil under soil application than foliar one.

Key words: Mineral and chelated micronutrient compounds, sandy soil, peanut, maize, foliar and soil application.

INTRODUCTION:

In Egypt, maize grains are one of the principle food for human consumption and animal feeding. Also, peanut is one of the most important and widely distributed crops in sandy soils.

The essential roles of micronutrients in plant metabolism, as activators or co-factor in all vital processes of a plant, can not be ignored. This leads undoubtedly to an increase in crop production, which is considered as the main goal in this respect (El-Kabbany *et al*., 1996). Morris *et al*., (1989) found that foliar application of the Fe, Mn and Zn increased grain and straw yield of wheat as well as their contents of N and P. Moussa *et al*. (1998) reported that the micronutrients (Fe, Mn and Zn) enhanced the seed yield and oil content of peanuts grown in sandy soil, because of their beneficial effect on some bio-process, and in turn on the growth of peanut plants. Salib, (2002) reported that the micronutrient significantlly increased the yield components of peanut, i.e., 100 seed weight, seed oil content and harvest index for peanut.

Foliar application of Mn to soybean plants as $MnSO_4$ (Soliman, 1986), $MnSO_4$ or Mn-EDTA (Ohki *et al*., 1987) increased the yield. Papastylianon, (1990) in field trials, studied the effectiveness of different Fe chelates (Fe-DDHA, Fe-EDDHA, Fe-DTPA, Fe-EDTA) and $FeSO_4$ to correct its availability to peanut plants under the adversable soil conditions. Among the tested chelates, Fe-EDDHA, Fe-DTPA and Fe-EDDHA were most effective in correcting Fe chlorosis. On the other hand, the application of $FeSO_4$ was not effective in Fe chlorosis correction. El-Basioni *et al*., (1995) showed that dry matter of different parts of maize plants were significantly affected by $FeSO_4$ or Fe-DDHA foliar application.

El-Naggar, (2004) stated that several plants can take up and absorb amino acids. He added also that the amino acids can bind with a metal to form a chelated metal. Therefore, the amino acids have used to chelate metal. Szajdak *et al*., (2004) stated that the application of amino acids for foliar use is based on its requirement by plants in general and at critical stage of growth in particular. They added that amino acids can be also supplied to the plants by incorporating them into the soil for improving the microflora and thereby facilitating the assimilation of nutrients.

The aim of the present work was to evaluate the soil and foliar applications of some micronutrients (Fe, Mn and Zn) as mineral sulphates or natural (-amino acids, -citrate, and -legnosulphonate) and synthetic (-EDTA) organic chelating compound on peanut and maize grown on sandy soil, with special reference to identify crop yields and their components as well as micronutrients uptake and residual effect on soil available micronutrients status.

MATERIALS AND METHODS:

Two field experiments were carried out on peanut (*Arachis hypogea*, Giza5) and maize (*Zea mays L*. Giza 2) crops grown on a sandy soil under sprinkler irrigation system at Ismailia Agric. Res. Station during the growing season of 2004. The applied treatments of the studied micronutrients (Fe, Mn and Zn) include:

a. Micronutrients as mineral sulphates, i.e., $FeSO_4$ (19.46 % Fe), $MnSO_4$ (24.63 % Mn) and $ZnSO_4$ (22.74 % Zn).

b. Micronutrients as chelating compounds, i.e., a. citrate (4.0% Fe, 4.3% Mn and 4.6% Zn), b. Amino acids (1.56% Fe, 1.56% Mn and 0.2% Zn), c. EDTA (6.0 % Fe, 6.0 % Mn and 6.0 % Zn) and Legnosulphonate (11.0% Fe, 12.0% Mn and 12.0% Zn).

Both mineral sulphates and chelating compounds were added to the plants as foliar spray and soil application in individual treatments, with special reference to the control treatments for both peanut and maize plants (an initial nutritional status). The mineral and chelating compounds were sprayed with 400 L/fed at a concentration of 500 mg/L and in the ratio of 3 Fe: 2 Mn : 1 Zn applied among two times, after 45 and 60 days from planting for either mineral or chelating compounds. Whereas in the soil application at the rate of 50 g chelating compounds for each cubic meter of irrigation water. The experiment was carried in fixed plots with an area of 10.5 m^2 (3x3.5 m) for each of peanut and maize crops. Each experiment was laid out in split plot, with twelve treatments, i.e., six for each foliar spray and soil application, while the micronutrient forms were randomized distribution in the fixed plots, with three replicates.

All peanut plots received N at a rate of 40 kg N/fed as ammonium sulphate (20.6% N) as a basal dose in two equal ones (after one and two months from planting), 31 kg P_2O_5/fed as supersulphate (15% P_2O_5) and 50 kg K_2O /fed as potassium sulphate (48% K_2O), both before cultivation. While maize received N at a rate of 120 kg N/fed as ammonium sulphate (20.6% N), in two equal ones, 30 kg P_2O_5/fed as supersulphate (15% P_2O_5) and 48 kg K_2O /fed as potassium sulphate (48 % K_2O) before cultivation.

Some physical, chemical and fertility properties of the investigated soil, Table (1), were determined according to methods described by Piper (1950), Richards (1954) and Jackson (1973). Available N, P, and K contents were extracted by 1% potassium sulphate, 0.5 M sodium bicarbonate and 1N ammonium acetate, respectively, and determined according to Jackson (1973). Available micronutrient contents of Fe, Mn and Zn were extracted by DTPA (Lindsay and Norvall 1978) and determined using Atomic Absorption Spctrophotometer. From the data obtained in Table (1), it could be concluded that the experimental soil is poorer from all aspects, where it is a skeletal in texture, weak in structure and unfavourable fertility status and moisture regime.

Yield components of both peanut and maize crops, i.e. weights of seed or grain, foliage or stover, 100 seed or grain were recorded. Peanut seed and maize grain were dried 70°C, ground in a wily mill and digested with H_2SO_4 and H_2O_2 according to Parakinson and Allen (1975) for N, P, K determinations (Van Schouwenberg, 1968). Also, the Fe, Mn and Zn were dtermined (Hess, 1971) using Atomic Absorption Spctrophotometer. Crud protein was calculated by multiplying N-concentration by 6.25 for peanut and 5.75 for maize according to AOAC (1975). The data obtained were subjected to statistical analysis according to Snedecor and Cochran (1980).

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

Soil characteristics	Value	Soil characteristics	Value
Particle size distribution %:		***Soluble cations (meq/L):***	
Sand	93.84	Ca^{2+}	0.49
Silt	4.10	Mg^{2+}	0.80
Clay	2.06	Na^{+}	0.78
Textural class	Sandy	K^{+}	0.25
Soil chemical properties:		*Soluble anions (meq/L):*	
pH (1:2.5 soil suspension)	7.71	CO_3^{2-}	0.00
$CaCO_3$ %	1.80	HCO_3^{-}	1.85
Organic matter %	0.25	Cl-	0.20
ECe (dS/m, soil paste extract)	0.23	SO_4^{2-}	0.27
Available macronutrients (mg/kg):		*Available micronutrients (mg/kg):*	
N	50.0	Fe	3.89
P	2.58	Mn	0.89
K	55.1	Zn	0.49

RESULTS AND DISSCUSION:

I. Effect of mineral and chelating compounds on the crop yield and its components

a. Peanut yield:

Data in Table (2) showed that there was a positive increase in peanut yield with insignificant differences between foliar spray and soil application methods. The positive effects of applied treatments could be arranged in the following descending order: amino acids > citrate > sulphate > EDTA = legnosulphonate.

The corresponding relative increases were 30.7, 16.6, 8.3, 7.8 and 7.6% for peanut seeds and 25.4, 20.9, 14.3, 11.0 and 10.2% for foliage, respectively, over the control treatment. It could be concluded that applying both mineral and chelating compounds as foliar application helps to compensate the effect of irrigation water defect on peanut yield. This result is in agreement with those of Suchutte and Heyden (1985) and Mengle and kirkby (1987).

b. Maize yield:

As for the influence of both foliar spray and soil applications on maize grain and stover under the different applied mineral and chelating compounds, data in Table (2) showed that yields of both grain and stover increased as a result of applied treatments with insignificant differences between the tested two methods of application.

Table 2: Seed or grain yields, 100 seed or grain of peanut and maize as affected by the mineral and chelating compounds.

Treatments (T)	Seed or grain yield (kg fed^{-1})			Weight of 100 seed or grain (g)		
	Application method (M)					
	Foliar	Soil	Means	Foliar	Soil	Means
	Peanut Crop					
Control	974.8	901.5	938.2	84.76	80.73	82.75
Sulphates	1055.7	1930.2	1043.0	96.67	94.0	95.34
Amino acids	1274.3	1130.3	1202.3	97.69	95.33	96.51
Citric acids	1136.4	1090.7	1113.6	97.15	94.91	96.03
EDTA	1051.3	1000.7	1026.0	90.63	92.5	91.57
Legnosulphonate	1049.3	993.8	1021.6	90.54	92.0	91.27
Means	1090.3	992.8		92.91	91.60	
LSD at $_{0.05}$	T 139.1	M 99.3	TM 121.1	T 1.09	M 1.73	TM 1.32
	Maize Crop					
Control	750.1	679.3	714.7	23.38	22.72	23.05
Sulphates	1435.2	1385.3	1410.3	27.35	26.72	27.04
Amino acids	1969.5	1891.8	1930.7	31.45	30.53	30.99
Citric acids	1606.7	1593.5	1600.1	31.04	30.10	30.57
EDTA	1201.7	1192.4	1197.1	27.26	26.00	26.63
Legnosulphonate	1175.4	1190.7	1183.1	25.95	24.71	25.33
Means	1356.4	1322.2		27.74	26.80	
LSD at $_{0.05}$	T 311.7	M 72.5	TM 223.7	T 2.03	M 1.23	TM 2.11

Also, the data show that amino acids treatment surpassed the other applied ones for maize yield, since its crop yield increased by 153.36 and 178.5% over the control treatment for foliar and soil application, respectively. This may be due to their more adhesion for chelating micronutrients, and enhancing their absorption and transportation inside the plant tissues in easier status. Moreover, amino acids micronutrient compounds are found in smaller molecules than other which that more suitable for cell membrane permeability. Amino acids act as a cytoplasm osmotic agents, thus lowering the opening of the stomata and consequently encourage plant metapolism and promote building blocks for protein synthesis. Accordingly, the positive effect of mineral and chelating compounds could be arranged as shown in a descending order of amino acids > citrate > sulphates > EDTA > legnosulphonate. In spite of there were insignificant differences between amino acids and citrate both exhibited a significant with the rest component. The less effect of legnosulphonate and EDTA may be due to its long-molecule size, which eliminate its absorption through cell membrane. Whereas the less effect of sulphates in comparing with amino acid and citrate may be due to the effect of these two compounds in enhancing metabolism in plant cells.

Regarding the 100 peanut seed, data in Table (2) indicate that the applied treatments showed a significantly superior for amino acids, where

100 seed weight increased by 15 % over the control treatment. Whereas, the inferiority increase (6.80 %) was associated with legnosalphonate treatment, with insignificant differences between the tested methods of application. As for the 100 maize grain, data indicate that a positively effect was associated with applied amino acids, which exhibited a highest increase reached 43.5 % over the control treatment, but there were no much differences among the other treatments.

II. Effect of mineral and chelating compounds on protein content for peanut and maize plants

a. Peanut:

Data in Table (3) indicate that the protein content in peanut seed and foliage increased as a result of all the tested treatments under both foliar spray and soil application, with insignificant differences among them.

Table 3: Protein contents of peanut seed or maize grain and foliage or stover as affected by the mineral and chelating compounds.

Treatments (T)	**Protein content (%)**					
	Seeds or Grain			Foliage or Stover		
	Application method (M)					
	Foliar	Soil	Means	Foliar	Soil	Means
Peanut Crop						
Control	17.62	17.75	17.69	5.06	5.13	5.10
Sulphates	22.62	21.81	22.22	12.31	11.88	12.10
Amino acids	23.87	23.44	23.66	17.62	17.50	17.56
Citric acids	22.62	22.06	22.34	16.31	15.81	16.09
EDTA	20.00	19.37	19.69	11.44	10.94	11.19
Legnosulphonate	18.12	17.38	17.75	10.19	10.12	10.16
Means	20.81	20.32		12.16	11.90	
LSD at $_{0.05}$	T 1.71	M 0.51	TM 0.95	T 1.96	M 0.34	TM 1.83
Maize Crop						
Control	9.89	9.78	9.84	7.13	7.07	7.10
Sulphates	12.48	12.36	12.42	9.20	9.14	9.17
Amino acids	13.88	13.74	13.81	9.43	9.49	9.46
Citric acids	13.17	12.83	13.00	9.43	9.32	9.38
EDTA	11.33	11.27	11.30	8.51	8.22	8.37
Legnosulphonate	10.35	10.24	10.30	7.71	7.59	7.65
Means	11.85	11.70		8.57	8.47	
LSD at $_{0.05}$	T 1.23	M 0.31	TM 0.78	T 0.20	M 0.49	TM 0.61

The corresponding increases for protein in seed were 33.7, 26.3, 11.3 and 3.38% over the control treatment for applied treatments of amino acids, citrate, sulphates, EDTA and legnosulphonate, respectively. Concerning the foliage content of protein, data reveal that, in general, the applied treatments showed a significant increase in protein content, with insignificant differences between sulphates, EDTA and legnosulphonate. The magnitudes of increase for amino acids, citrate, sulphates, EDTA and legnosulphonate were 244.3, 214.9, 137.2, 119.4 and 99.2% over the control treatments, respectively.

b. Maize:

Protein content in both maize grain and stover, Table (3), showed markedly increases as a result of applied mineral and chelating compounds as compared to the control treatment. Data indicate also that the amino acids was the superior treatment for increasing grain or stover protein at both tested methods, with insignificant differences among them. The percentages of the protein content in the maize grain differed according to the applied micronutrient forms. Furthermore, data in Table (3) pointed out that the protein content increased with a percentage ranged 40.3-4.7% for grain and 33.2-7.7% for stover at applied methods as compared to the control treatment. The effect of the used mineral and chelating compounds on increasing protein content of both maize grain and stover could be arranged into: amino acids > citrate > sulphates > EDTA > legnosulphonate> control treatment for grain vs amino acids > citrate > sulphates > EDTA > legnosulphonate> control treatment for stover.

These results can be explained on the basis as the studied micronutrients are involved directly or indirectly in formation of starch, protein and other biological components through their role in the respiratory and photosynthesis mechanisms as well as their roles in the activity of various enzymes (Monged *et al*., 1993 and Nassar *et al*., 2002).

III. Effect of mineral and chelating compounds on nutrient contents and uptake by peanut and maize plants:

a. Macro and micronutrient contents in peanut plants:

Data in Table (4) show that the contents of N, P and K in peanut plants increased progressively as a result of applied mineral and chelating forms, with insignificant differences between foliar spray and soil application. Nitrogen contents in seeds and foliage varied widely according to the applied treatments, where the obtained values of increases followed an order of amino acids > citrate = sulphates > EDTA > legnosulphonate. These results are also affected by the influence of soil and plant characteristics on dry matter yield of peanut plants, particularly soil biological conditions, nitrogen metabolism and photosynthesis processes. Similar results were obtained by Mersal (1996). Also, data in Table (4) indicate that P and K contents tended to increase with different applied mineral and chelating forms as foliar and soil application in peanut plants grown on the studied sandy soil.

The general trend of the increments for both P and K contents in peanut seed and foliage followed an order of amino acids > citrate > sulphates > EDTA > legnosulphonate, with in significant differences between amino acids and citrate as well as EDTA and legnosulphonate. The superior effect of amino acids may be due to their role in assimilation processes of organic and inorganic phosphorus compounds (phospholipids, phosphoproteins and phosphocarbohydrates). Nassar (1997) found that the addition of micronutrients simultaneously gave an additional enhancing effect in N, P and K contents, this may be due to the suitable balance between the aforementioned macronutrients, which enable the plants to grow well and to absorb more quantities of N, P and K.

Table 4: Effect of mineral and chelating compounds on peanut seed and foliage macronutrient contents.

Treatments (T)	Macronutrient contents (%)								
	N			P			K		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
Seeds									
Control	2.82	2.84	2.83	0.38	0.36	0.37	1.48	1.50	1.49
Sulphates	3.62	3.49	3.56	0.53	0.50	0.52	1.65	1.67	1.66
Amino acids	3.82	3.75	3.79	0.63	0.61	0.62	1.70	1.71	1.70
Citric acids	3.62	3.53	3.58	0.56	0.53	0.55	1.66	1.65	1.65
EDTA	3.20	3.10	3.15	0.53	0.49	0.42	1.63	1.65	1.64
Legnosulphonate	2.90	2.78	2.84	0.43	0.41	0.42	1.53	1.53	1.53
Means	3.33	3.25		0.45	0.48		1.60	1.62	
LSD at $_{0.05}$	T 0.311	M 0.19	TM 0.210	T 0.02	M 0.05	TM 0.03	T 0.04	M 0.07	TM 0.03
Foliage									
Control	0.81	0.82	0.81	0.28	0.30	0.290	0.58	0.55	0.565
Sulphates	1.97	1.90	1.94	0.35	0.34	0.345	1.87	1.88	1.860
Amino acids	2.82	2.80	2.81	0.37	0.40	0.385	2.33	2.34	1.980
Citric acids	2.61	2.53	2.57	0.36	o.35	0.355	1.89	1.90	1.895
EDTA	1.83	1.75	1.79	0.32	0.30	0.310	1.85	1.88	1.840
Legnosulphonate	1.63	1.62	1.62	0.31	0.29	0.300	1.68	1.70	1.675
Means	1.95	1.90		0.33	0.33		164.5	1.626	
LSD at $_{0.05}$	T 0.31	M 0.06	TM 0.48	T 0.031	M 0.010	TM 0.022	T 0.05	M 0.03	TM 0.06

Results of the micronutrient contents (Fe, Mn and Zn) in peanut seed and foliage, as shown in Table (5), showed an increase for each of them as a result of applying the tested mineral and chelating micronutrient compounds, with more pronounced in foliage than seed. The superiority of the applied forms were arranged as follows: amino acids > citrate > sulphates > EDTA > legnosulphonate in a general view for both peanut seed and foliage.

Table 5: Effect of mineral and chelating compounds on peanut seed and foliage micronutrient contents.

Treatments (T)	Micronutrient contents (%)								
	Fe			Mn			Zn		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
Seeds									
Control	238	243	240.5	80	77	78.5	125	120	122.5
Sulphates	370	365	367.5	88	87	87.5	145	142	143.5
Amino acids	633	630	631.5	95	90	92.5	198	196	197.0
Citric acids	443	441	442.0	90	88	89.0	175	170	172.5
EDTA	318	320	314.0	85	84	84.5	143	140	141.5
Legnosulphonate	283	210	281.5	83	80	81.5	135	132	133.5
Means	380.1	378.2		86.8	84.3		154	150	
LSD at $_{0.05}$	T 190.1	M 15.0	TM 192.5	T 4.3	M 5.2	TM 6.2	T 4.1	M 26.7	TM 30.9
Foliage									
Control	565	560	562.5	68	66	67	80	78	79.0
Sulphates	760	757	758.5	80	82	81.0	135	130	132.5
Amino acids	991	985	988.0	95	92	93.5	143	140	141.5
Citric acids	980	973	976.5	90	87	88.5	138	134	136.0
EDTA	760	755	757.5	78	72	75.0	133	139	131.0
Legnosulphonate	668	662	665.0	75	70	72.5	128	125	128.5
Means	881.5	783.7		81	78		126.2	122.7	
LSD at $_{0.05}$	T 19.4	M 99.8	TM 15.5	T 5.3	M 7.2	TM 7.9	T 6.1	M 7.3	TM 5.3

b. Macro and micronutrient contents in maize plants:

Data in Table (6) reveal that both macro (N, P and K) and micronutrients (Fe, Mn and Zn) exhibited significantly increases in both maize grain and stover due to applying the tested mineral and chelating compounds. However, the highest values were strictly associated with applied amino acids, since N content increased in grain and stover by 40.3 and 31.2 % over the control treatment, respectively, with insignificant differences between amino acids and citric acids. Also, data reveal that a high K content in stover, as it reached about three times of grain.

Results of micronutrient contents (Fe, Mn and Zn) in maize grain and stover, as shown in Table (7), showed pronounced increases for all the tested treatments, with superiority for amino acids. The positive role of amino acids is more attributed to improve the efficiency of nutrients uptake and enhancing dry matter yield, and in turn the quality of maize grains. The beneficial effects of the applied mineral and chelating compounds could be arranged into: amino acids > citrate > sulphates > EDTA > legnosulphonate.

Table 6: Effect of mineral and chelating compounds on maize grain and stover macronutrient contents.

Treatments (T)	Macronutrient contents (%)								
	N			P			K		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
	Grain								
Control	1.72	1.70	1.71	0.53	0.51	0.520	0.30	0.29	0.295
Sulphates	2.17	2.20	2.16	0.56	0.54	0.550	0.57	0.54	0.550
Amino acids	2.41	2.42	2.40	0.65	0.64	0.645	0.41	0.40	0.605
Citric acids	2.29	2.33	2.26	0.60	0.55	0.595	0.58	0.56	0.570
EDTA	1.97	1.96	1.97	0.56	0.54	0.550	0.56	0.55	0.550
Legnosulphonate	1.80	1.78	1.79	0.55	0.52	0.535	0.50	0.48	0.495
Means	2.06	2.04		0.545	0.557		0.508	0.503	
LSD at $_{0.05}$	T 0.27	M 0.03	TM 0.25	T 0.041	M 0.023	TM 0.034	T 0.042	M 0.010	TM 0.035
	Stover								
Control	1.24	1.23	1.23	0.27	0.25	0.260	0.53	0.55	0.54
Sulphates	1.60	1.59	1.60	0.37	0.36	0.365	0.77	0.79	0.78
Amino acids	1.64	1.64	1.64	0.49	0.48	0.485	0.96	0.95	0.96
Citric acids	1.64	1.62	1.63	0.41	0.41	0.410	0.79	0.80	0.80
EDTA	1.48	1.43	1.46	0.34	0.31	0.325	0.74	0.72	0.73
Legnosulphonate	1.34	1.32	1.33	0.28	0.27	0.275	0.68	0.67	0.68
Means	1.49	1.48		0.36	0.34		0.72	0.75	
LSD at $_{0.05}$	T 0.09	M 0.05	TM 0.03	T 0.07	M 0.05	TM 0.09	T 0.011	M 0.021	TM 0.012

Table 7: Effect of mineral and chelating compounds on maize grain and stover micronutrient contents.

Treatments (T)	Micronutrient contents (%)								
	Fe			Mn			Zn		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
	Grain								
Control	238	240	240.5	53	50	51.5	128	126	127
Sulphates	370	365	367.5	65	61	63.0	155	150	152.5
Amino acids	633	630	631.5	68	67	67.5	168	167	167.5
Citric acids	443	441	442.0	65	63	64.0	163	160	161.5
EDTA	318	310	314.0	63	60	61.5	150	145	147.5
Legnosulphonate	283	280	281.5	53	51	52.0	145	144	144.5
Means	380.1	378.2		61.2	58.7		1515	148.7	
LSD at $_{0.05}$	T 17.5	M 56.2	TM 56.7	T 3.0	M 3.7	TM 4.5	T 8.1	M 5.9	TM 6.7
	Stover								
Control	298	238	295.5	45	43	44.0	65	62	63.5
Sulphates	477	475	467.0	70	69	69.5	138	135	136.5
Amino acids	635	630	632.5	83	80	81.5	153	150	151.5
Citric acids	550	547	548.5	73	71	72.0	145	142	143.5
EDTA	475	470	472.5	70	67	68.5	133	131	132.0
Legnosulphonate	370	368	369.0	60	53	58.5	105	103	104.0
Means	467.5	463.8		66.8	64.5		123.2	120.5	
LSD at $_{0.05}$	T 87.1	M 5.2	TM 97.2	T 2.9	M 10.3	TM 10.0	T 3.7	M 16.8	TM 12.5

Tables (8 and 9) show that the used treatments caused an increase in each of macro (N, P and K) and micronutrients (Fe, Mn and Zn) uptake by peanut seed, with a superior effect for amino acids and inferiority for legnosulphonate, while EDTA in between. The abovementioned results can be explained on the basis of increasing the corresponding values of both seed and foliage yields.

Table 8: Effect of mineral and chelating compounds on peanut seed and maize grain macronutrients uptake.

Treatments (T)	Macronutrient uptake (kg fed^{-1})								
	N			P			K		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
Peanut seed									
Control	27.5	27.9	27.6	3.70	3.25	3.41	14.67	13.52	13.98
Sulphates	38.2	35.9	37.1	5.59	5.15	5.37	17.42	17.20	17.31
Amino acids	48.6	42.4	45.5	8.02	6.89	7.46	21.66	19.22	20.44
Citric acids	41.1	38.0	39.8	6.36	5.78	6.07	18.86	17.99	18.43
EDTA	33.6	31.1	32.4	5.57	4.09	5.24	17.14	16.51	16.83
Legnosulphonate	28.9	27.6	28.3	4.29	4.07	4.18	15.30	15.21	15.23
Means	36.3	33.9		5.59	5.00		17.47	16.61	
LSD at $_{0.05}$	T 7.11	M 4.57	TM 5.23	T 2.31	M 1.78	TM 1.45	T 1.52	M 2.91	TM 3.21
Maize grain									
Control	12.90	11.55	12.23	3.98	3.46	3.79	2.29	1.96	2.23
Sulphates	31.14	29.78	30.59	8.04	7.48	7.76	8.18	7.40	7.79
Amino acids	45.80	45.21	45.51	12.35	12.10	12.23	11.59	11.35	11.47
Citric acids	36.79	35.54	36.17	9.64	8.76	9.20	9.32	8.92	9.12
EDTA	23.67	23.37	23.52	6.73	6.44	6.59	6.73	6.56	6.65
Legnosulphonate	21.16	21.19	21.18	6.46	6.19	6.33	5.88	5.72	5.80
Means	28.58	27.77		7.87	7.41		7.33	6.99	
LSD at $_{0.05}$	T 10.50	M 2.81	TM 11.81	T 4.5	M 0.98	TM 3.62	T 2.54	M 1.02	TM 1.95

c. Macro and micronutrients uptake by peanut seed:

Nitrogen, phosphorus and potassium uptake ranged between 45.50-28.27, 7.46-4.18 and 20.44-15.23 kg/fed, respectively. It was observed that P and K uptake showed an increase reached two times over the control treatment at amino acids one. While, legnosulphonate exhibited slightly increases for P and K uptake as compared to the control treatment.

Concerning micronutrients (Fe, Mn and Zn) uptake by peanut seed, data in Table (9) show that Fe uptake in grain was progressive increased, and reached its maximum figure (235.7 %) in the case of amino acids treatment. Manganese and Zn uptake ranged between 73.7-83.3 and 115.0-136.5 g/fed, respectively, and they positively affected by mineral and all chelating compounds, with no much differences between the values of sulphates and EDTA treatments.

Table 9: Effect of mineral and chelating compounds on peanut seed and maize grain micronutrients uptake.

Treatments (T)	Micronutrient uptake (g fed^{-1})								
	Fe			**Mn**			**Zn**		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
Peanut seed									
Control	232.0	219.1	225.6	77.9	69.4	73.7	121.8	108.2	115.0
Sulphates	3906	376.0	383.3	92.9	89.6	91.3	153.0	146.3	149.7
Amino acids	806.6	713.1	759.7	121.0	101.7	111.4	252.3	221.5	236.9
Citric acids	503.4	480.9	492.2	102.2	95.9	99.1	198.8	185.4	192.1
EDTA	334.3	310.2	322.3	89.3	84.1	86.7	150.3	140.1	145.2
Legnosulphonate	296.9	278.2	287.6	87.1	79.5	83.3	141.7	131.2	136.5
Means	427.2	396.3		95.1	86.7		169.7	155.5	
LSD at $_{0.05}$	T 133.1	M 35.2	TM 152.5	T 12.5	M 10.7	TM 20.9	T 45.9	M 17.9	TM 57.0
Maize grain									
Control	179.0	163.0	171.0	39.7	33.9	36.8	96.0	85.8	90.9
Sulphates	531.0	511.1	521.1	91.0	84.5	87.8	222.4	207.8	215.6
Amino acids	936.9	813.4	875.2	129.2	126.8	128.0	319.2	315.9	317.6
Citric acids	711.8	699.5	705.7	108.8	100.4	104.6	261.9	254.9	258.4
EDTA	382.1	373.2	377.7	88.2	71.5	79.9	180.2	172.9	176.6
Legnosulphonate	332.6	333.4	333.0	62.3	60.7	61.5	170.4	171.5	170.9
Means	512.2	477.8		86.5	79.6		208.4	201.5	
LSD at $_{0.05}$	T 179.1	M 42.7	TM 211.8	T 26.7	M 8.8	TM 22.1	T 123.1	M 10.5	TM 112.5

d. Macro and micronutrients uptake by maize grain:

Also, data in Table (8) indicate that N, P and K uptake by maize grain as affected by mineral and chelating compounds showed pronounced increases and followed an order of amino acids > citrate > sulphates > EDTA = legnosulphonate > control. Protein content in the maize grain showed a similar trend of N, P and K uptake.

Data showed in Table (9) that the highest increments of Fe, Mn and Zn uptake by maize grain were occurred when the plants were sprayed or treated as soil application by amino acids, as the corresponding increases in the case of amino acid treatments reached 875.2, 120.0 and 177.6 g/fed over the control treatment, respectively. The relatively lesser increases of micronutrients were associated with legnosulphonate treatment and reached 33.0, 61.5 and 170.9 g/fed over the control treatment, respectively.

From the abovementioned results it was cleared that the contents of N, P, Fe and Zn were greater in both peanut seed and maize grain than that in foliage and stover. Whereas, K and Mn contents behaved an opposite trend. Also, N uptake in peanut seed was more pronounced than that in maize grain, while the Fe uptake was greater in the maize grain than that in peanut seed.

IV. Residual effect of mineral and chelating compounds on available micronutrient contents in soil:

The magnitudes of available micronutrients in the studied sandy soil as affected by the applied treatments are shown in Table (10). The obtained data show that the studied Fe, Mn and Zn lay within the low-medium range according to the critical levels of micronutrients undertaken by Lindsay and Norvell (1978) for both peanut and maize at all applied mineral and chelating compounds. In general, this is true since these soils are not only poor in the nutrients bearing minerals, but also in organic and inorganic colloids, which are considered a storehouse for the essential plant nutrients.

Table 10: Effect of mineral and chelating compounds on micronutrients availability in soil under investigation .

Treatments (T)	**Soil availability (g fed^{-1})**								
	Fe			**Mn**			**Zn**		
	Application method (M)								
	Foliar	Soil	Means	Foliar	Soil	Means	Foliar	Soil	Means
Peanut Crop									
Control	1.989	1.989	1.989	1.044	1.044	1.044	0.487	0.487	0.487
Sulphates	2.139	3.788	2.964	1.272	2.184	1.728	0.577	0.991	0.784
Amino acids	2.178	4.167	3.172	1.308	2.393	1.851	0.599	1.085	0.842
Citric acids	2.160	3.977	3.069	1.300	2.291	1.800	0.581	1.033	0.807
EDTA	2.101	3.600	2.851	1.239	2.077	1.658	0.550	0.946	0.748
Legnosulphonate	2.081	3.409	2.745	1.121	1.975	1.548	0.539	0.893	0.716
Means	2.108	3.488		1.215	1.995		0.556	0.906	
LSD at $_{0.05}$	T 0.121	M 1.101	TM 0.180	T 0.161	M 0.53	TM 0.253	T 0.052	M 0.213	TM 0.019
Maize Crop									
Sulphates	2.163	3.903	3.033	1.207	2.039	1.623	0.541	1.014	0.778
Amino acids	2.241	4.405	3.323	1.250	2.486	1.868	0.567	1.135	0.851
Citric acids	2.202	4.221	3.212	1.228	3.494	1.861	0.555	1.056	0.806
EDTA	2.124	3.611	2.868	1.184	2.055	1.620	0.533	0.956	0.745
Legnosulphonate	2.085	3.544	2.815	1.131	1.960	1.546	0.520	0.919	0.720
Means	2.134	3.612		1.174	2.013		0.534	0.928	
LSD at $_{0.05}$	T 0.112	M 1.73	TM 0.551	T 0.312	M 0.735	TM 0.101	T 0.053	M 0.213	TM 0.092
*Critical limits of micronutrients in mg kg^{-1}**									
Critical limits	Fe			Mn			Zn		
Low	< 4.0			< 2.0			< 1.0		
Medium	4.0 - 6.0			2.0 - 5.0			0.5 - 1.0		
High	> 6.0			> 5.0			> 1.0		

*Critical levels of micronutrients after Lindsay and Norvell (1978)

On the other hand, the results obtained from the treated plants (foliar spray or soil application) showed a progressive increase in the available micronutrient contents, with a significantly effect between each of the applied methods (foliar and soil application). The same trend was obtained as what previously mentioned at the plant used, as the high significant effect was associated with amino acids as compared to the other tested treatments.

CONCLUSION:

The abovementioned presentation and discussion suggested a similarity between each of the studied crops as regarded to foliar spray or soil application. If this true, the selection for particular method of organic-micronutrient compounds application could suggest dependent on the economical point of view.

The amino acids offered higher values for the all parameters than that of other tested treatments for both crops (peanut and maize). Of course, such variations could be a resultant of the use efficiency or the physiological efficiency, beside the other forms concerned with the nature of the tested treatments and soil characteristics.

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تأثيرالإضافة بالرش أو للتربة لبعض العناصر الصغرى فى صور معدنية وعضوية علي المحصول ومكوناته لكل من الفول السوداني والذرة الشامية النامية فى أرض رملية

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أجريت تجربتين حقليتين في أرض رملية منزرعة بمحصولين صيفيين هما الفول السوداني (جيزه ٥) الذرة الشامية (جيزه ٢) تحت نظام الرى بالرش خلال الموسم الصيفي لعام ٢٠٠٤ بمزرعة محطة البحوث الزراعية بالأسماعيلية، وذلك بهدف تقييم تأثير الرش الورقي أو الإضافة للتربة لبعض العناصر الصغري فى صورة مركبات معدنية (كبريتات الحديد، المنجنيز، الزنك) أو مخلبية- عضوية (الأحماض الأمينية، السترات، اللجنوسلفونات) أو مخلبيه مخلقة (إيثلين داى أمين تترا أستيك آسيد) كمعاملات منفردة لكل منهم علي المحصول ومكوناتة لكلا المحصولين تحت الدراسة، مع إعطاء أهمية لمحتوى بذور الفول السوداني وحبوب الذرة الشامية من عناصر N, P,

K, Fe, Mn and Zn، بالإضافة إلى معرفة التأثير المتبقى لتلك المعاملات تحت نظم الإضافة المختلفة على محتوى التربة الميسر من عناصر Fe, Mn and Zn .

وتدل النتائج المتحصل عليها إلى أن هناك إستجابة معنوية فى زيادة محصولى الفول السوداني والذرة الشامية كنتيجة لإضافة جميع المعاملات تحت الدراسة، كما هو موضح فى الترتيب التنازلى الآتى تبعا لكفاءة كل منها :

Amino acids > citrate > sulphates > EDTA > legnosulphate

حيث سجلت المعاملة بالأحماض الأمينية تفوق علي جميع المعاملات الأخري، وقد تبين ذلك من الإرتفاع الملحوظ والمعنوى في قيم محتوي القش وبذور الفول السوداني وحبوب الذرة من البروتين أو ١٠٠ بذرة أو حبة، ولقد سجلت المعاملة باللجنوسلفونات أقل الزيادات، بينما احتلت المعاملة بكل من السترات و إيثلين داى أمين تترا أستيك آسيد وضع وسطي بينهما . وربما ترجع أفضلية المعاملة بالأحماض الأمينية إلى قدرتها على خلب المغذيات الصغرى مما يشجع من إمتصاصها ونقلها داخل النباتات بصورة أيسر، علاوة على صغر حجم جزيئات المخلبيات العضوية الموجدة فى صورة الأحماض الأمينية مما يجعلها أكثر ملائمة لنفاذية الجدر الخلوية . أما عن طريقة الإضافه، فقد كان الرش الورقي أفضل مقارنة بالإضافه الأرضية، ولكن الفروق بينهما كانت غير معنوية مؤكده.

وبالنسبة إلي تأثير كل من الصور المضافة علي الحالة الغذائية لكل من نباتات المحصولين تحت الدراسة، فقد أظهرت النتائج أن هناك تأثير إيجابي ومعنوى علي محتوي القش والبذور للفول السوداني والحبوب والسيقان للذرة الشامية من النيتروجين والفسفور والبوتاسيوم، مع أفضلية لمعاملة بالأحماض الأمينية. كما سجلت قيم كل من النيتروجين والفسفور أعلي محتوي فى كل من بذور الفول السودانى وحبوب الذرة الشامية مقارنة بما يحتويه قش الفول السودانى وسيقان الذرة الشامية، بينما أظهرت النتائج أن هناك إتجاه عكسي بالنسبة لعنصر البوتاسيوم فقد أظهر قيم مرتفعة في القش والسيقان عن البذور والحبوب. وبالنسبة إلى حالة محتوي النباتات من العناصر الصغري (الحديد، المنجنيز، الزنك) فقد كان هناك تأثير أيجابي ومعنوى علي المحتوى لكل منهم في القش والبذور للفول السوداني والحبوب للذرة الشامية، مع زيادة نسبية في قيم كل من الحديد والزنك في الحبوب، مقابل زيادة فى قيم المنجنيز لقش الفول السودانى.

وعلي الوجه الآخر فقد كان التأثير المتبقى للمعاملات تحت الدراسة على محتوى التربة الميسر من عناصر Fe, Mn and Zn أكبر فى حالة الإضافة الأرضية عنه فى حالة الرش الورقى، وأيضا هناك تأثير إيجابي لمعاملة الأحماض الامينيه علي عكس ما هو حادث فى معاملة اللجنوسلفونات. ومما سبق يمكن أستنتاج أن إضافة العناصر الصغري رشا أو أرضا علي صورة معدنية أو مخلبية-عضوية قد أدي إلي زيادة فى محصولى بذور الفول السودانى وحبوب الذرة الشامية، وكذا محتواهما من البروتين، وزن ١٠٠ بذرة أو حبة، كما أدي ذلك إلي تحسن الحالة الغذائية للنباتات المنزرعة. وكان هذا أيضا مؤكدا عند إضافة تلك العناصر الصغري فى صورة مخلبية للأحماض الأمينية والسترات والذى كان لهما التأثير الأيجابي على حالة النباتات النامية فى التربة الرملية تحت نظام الري بالرش، ولقد سجلت أقل استفادة في حالة الإضافة رشا أو أرضا علي صورة اللجنوسلفونات لتدنى قيم الزيادة المتحصل عليها من تلك المعاملة.