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EFFECT OF FOLIAR SPRAYING BY SOME MICRONUTRIENTS ON GROWTH, YIELD, CHEMICAL CONSTITUENTS AND ANATOMICAL STRUCTURE OF COTTON PLANTS (*Gossypium vitifolium* L.) GROWN IN NEWLY RECLAIMED SANDY SOIL.

BY

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ABSTRACT

Two field experiments were carried out in the two successive seasons of 2002 and 2003 to study the effect of spraying some micronutrients namely, Fe, Mn and Zn either alone or in combination at rates of 0.05, 0.08 and 0.1 % as chelated nutrient on vegetative growth, yield and its components, chemical constituents and anatomical structure of cotton (*Gossypium vitifolium* L.) plants (cultivar Giza 70) grown under newly reclaimed soil conditions . The results indicated that increasing the rates of Fe, Mn and Zn applied either alone or in combination caused an increase in plant height, number of leaves / plant, number of main stem internodes / plant, leaf area and number of fruit branches / plant and dry weight of leaves / plant in the case of vegetative growth, in addition to increasing the number of bolls / plant, number of opened bolls / plant, weight of boll / plant, weight of seeds / plant and yield of seed cotton / fed. at the harvesting stage . Similar trend was observed for the chemical constituents of cotton plants i.e. N, P, K, Fe, Zn, Mn, total carbohydrates, total chlorophylls and carotenoids concentrations in leaves, crude proteins and oil concentrations in seeds . As for the effect of micronutrients on the anatomical structure of stem and leaf of cotton plants, the results indicated positive effects with all the studied characters of plant organs. The highest increases in this experiment was obtained by the treated plants with the combined treatment of (Fe + Mn + Zn) especially at the highest rate (0.1 %),in the two seasons. Hence, under newly reclaimed soil conditions refer to spraying cotton plants with a mixture of these micronutrients at a rate of 0.1 % exhibited optimum in yield and its components.

INTRODUCTION

Cotton (*Gossypium vitifolium* L.) plant is a very important and strategic crop for national income, it is well known that nutrition represents the most important factor affecting the yield specially in new reclaimed sandy soils.

In addition to the macro-elements, micro-elements are necessary for plant growth and development. The micronutrients in general play an important

role in the physiological and metabolic processes in cotton plants during the different stages of growth (Azab *et al.* 1992) . In recent years, great efforts of Egyptian scientists tend to study the possibility to cultivate cotton in newly reclaimed sandy soils.

The productivity of plants in newly reclaimed sandy soils is very low due to its poor fertility especially in micronutrients. Many researchers have recorded the beneficial effects of micronutrients (especially, Fe, Mn and Zn)on vegetative growth, yield and its components, chemical constituents of cotton plants, Girgis, (1992);Wahdan *et al.*(1994); El- Kashlan *et al* .(1995); Abd El-Shafy, (1998); Darwish and Hegab, (2000); Salem and Mohmed (2000); Wassel *et al.* (2000); and Abd El-Shafy *et al* . (2001) .

The present study aimed to investigate the effect of spraying with some micronutrients namely, Fe, Mn and Zn either alone or in combination on vegetative growth, yield and yield components, chemical constituents and anatomical structure of cotton (*Gossypium vitifolium* L.) plants grown under newly reclaimed soil conditions, in order to discover the positive effect of these micro- elements and their importance in the introduction of this cotton plants to be cultivated in the reclaimed soil.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons, 2002 and 2003, in the Experimental Station (Demo area), Faculty of Agriculture, Fayoum, Cairo Univ.

Results of mechanical and some chemical analysis of the used soil are carried out according the standard methods described by Olsen and Sommers (1982) and Page *et al.* (1982) in Table (1) .

Table (1): Mechanical and some chemical analysis of the tested applied soil:-

Mechanical analysis				Available nutrients (mg / Kg)							
Sand %	Silt %	Clay %	Texture class	Soil pH	$CaCo_3$ %	N	P	K	Fe	Mn	Zn
71.50	15.70	12.80	sand loam	8.3	6.5	17.4	10.2	275	2.5	0.95	0.30

Seeds of cotton (*Gossypium vitifolium* L.) cultivar Giza 70, were obtained from Cotton Research Center, Ministry of Agriculture, Egypt. Seeds were sown on 15 th of March (for two seasons) . Five seeds were sown in each hill 25 cm apart and then were thinned (at the age of 30 days) to one plant . The normal cultural practices for growing cotton plants were followed .

Fertilization: The plants received the rates of 300kg / fed. Ammonium nitrate (33.5 % N), 300 kg / fed. superphosphate (15.5 % P_2O_5) and 50 Kg / fed. Potassium sulphate (48 % K_2O) as recommended by Ministry of Agriculture, of Egypt . Nitrogen fertilizer was applied after thinning and after two months (35

and 60 days after sowing) . Phosphorus and potassium fertilizers were incorporated into the soil before sowing.

Treatments: The three micronutrients namely, Fe, Mn and Zn at the rates of 0.05, 0.08 and 0.1 % for each element were applied at three times during the growing season . The first was after thinning, the second one month after the first addition and the third at the beginning of the flowering.

The experiment involved the following 13 treatments:

1- Control (spraying with tap water).
2- Spraying chelated Fe (Fe- EDTA) at the rate 0.05 % .
3- Spraying chelated Fe (Fe- EDTA) at the rate 0.08 % .
4- Spraying chelated Fe (Fe- EDTA) at the rate 0.1 % .
5- Spraying chelated Mn (Mn - EDTA) at the rate 0.05 % .
6- Spraying chelated Mn (Mn - EDTA) at the rate 0.08 % .
7- Spraying chelated Mn (Mn - EDTA) at the rate 0.1 % .
8- Spraying chelated Zn (Zn - EDTA) at the rate 0.05 % .
9- Spraying chelated Zn (Zn - EDTA) at the rate 0.08 % .
10- Spraying chelated Zn (Zn - EDTA) at the rate 0.1 % .
11- Spraying the three nutrients together at the rates 0.05 % .
12- Spraying the three nutrients together at the rates 0.08 % .
13- Spraying the three nutrients together at the rates 0.1 % .

Recording data:-

1- Morphological parameters;

At the age of 120 days (in the two seasons), 10 plants from each replicate were randomly taken to estimate the following morphological parameters:-

- Plant height (cm) was measured from the cotyledonary node to the terminal bud.
- Number of main stem internodes / plant .
- Number of leaves / plant .
- Area of the 7 th leaf from the apex of cotton plant (fully expanded leaf), using an area meter, model Li 3000 from LI C O R E, U S A.
- Number of fruit branches / plant .
- Dry weight of leaves / plant (g) (the samples were dried in an electric oven at 70 °C +2 till constant weight) .

2- Yield and its components:-

At harvesting stage (aged 165 days for both seasons), 10 cotton plants from each replicate were randomly taken to study the yield and its components considering:-

- Average number of bolls / plant .
- Average number of opened bolls / plant.
- Average weight of dry opened boll (g) / plant
- Average weight of seeds (g) / plant .
- Average yield of seed cotton (kg) / feddan

3- Chemical constituents:-

The following chemical constituents were determined in the two seasons in the powdered dry leaves and seeds (the samples were dried in an electric oven at 70 °C +2 till constant weight, then finely ground).

- Nitrogen % was determined, using the Orange G dye clorimetric method (Hafez and Hikkelsen 1981).
- Crude protein in seeds was determined according to A.O.A.C. (1995) .
- Phosphorus % was determined after digesting the powdered dry materials as recorded by Olsen and Sommers (1982).
- Potassium % was determined after digesting the powdered dry materials as stated by Page *et al.* (1982).
- Oil content of seeds was determined using Soxilt method according to A.O.A.C. (1995) .
- Total carbohydrates (%) were determined calorimetrically according to the method described by Herbert *et al.*, (1971).
- At age of 130 days (in both seasons) samples of fresh leaves were taken for determination of total chlorophyll and carotenoids which extracted by acetone and were determined according to Welburn and Lichtenthaler, (1984).

Micronutrients were estimated using the Atomic Absorption Spectrophotometer.

4- Anatomical studies:

Here, specimens of selected treatments at the age of 130 days (in the second season) were taken for examination.

- The middle part of the 7 th internode and its leaf from the apex of cotton plant were considered .
- These specimens (1 cm long) were killed and fixed in FAA solution (10 ml formalin + 5 ml glacial acetic acid + 85 ml ethyl alcohol 70%) for 2 days, then washed in 50 % ethyl alcohol, dehydrated, cleared in a series of normal butyl alcohol and embedded in paraffin wax (56 - 58 °C m.p.). Cross sections, 25 u thick were cut by a rotary microtome, adhesived on slides by Hauptts adhesive and double stained with the crystal violet erythrosine combination, cleared in carbolic xylene and mounted in Canada balsam (Willey, 1971).

The previous experiment was laid out in complete randomized block design, with three replicates. The plot size was (4 x 4 m^2) which included 6 rows 60 cm apart . The experiment contained 13 treatments. Results were statistically analyzed using the LSD at probability level of 5% for comparisons (Gomez and Gomez, 1983).

RESULTS AND DISCUSSIONS

1- Growth parameters:

Data in Table (2) indicate that spraying cotton plants with the applied micronutrients caused beneficial effect on plant growth. The treated plants with one of Fe, Zn and Mn (especially at the rate of 0.1 %) showed a pronounced increase in growth parameters reached, 16.47, 30.59 and 11.29 % for plant height; 14.29, 20.00 and 7.43 % for number of main stem internodes; 18.55, 23.64 and

16.36 % for number of leaves / plant; 19.68, 39.36 and 31.05% for leaf area; 20.10, 22.86 and 12.88 % in dry weight of leaves / plant and 21.53, 38.89 and 38.19 % for number of fruit branches / plant, respectively, as compared to the untreated plants, at the first season .

Regarding the effect of the combined treatment of the three elements on cotton plants, data in Table (2) showed that the growth parameters significantly increased, reached (35.29, 40.47and 45.53 % for plant height; 22.86, 28.57 and 31.43 % for number of main stem internodes; 32.73, 37.45 and 45.45 % for number of leaves / plant; 55.54, 62.54 and 75.59 % for leaf area; 22.86, 30.93 and 35.38 % for dry weight of leaves / plant and 58.33, 59.72 and 75.97 % for number of fruit branches / plant) by increasing the rates of Fe or Zn or Mn mixture from 0.05 up to 0.08 and 0.1 %, respectively, compared with the untreated plants, at the first season . The same trend nearly existed in the second season.

Table (2): Effect of solely and combined application of Fe, Zn and Mn on the growth parameters of cotton plants grown in newly reclaimed sandy soil.

Characters		Plant height (cm)		Number of internodes / main stem		Number of leaves / plant		Leaf area (cm 2)		Dry weight of leaves / plant (g)		Number of fruit branches / plant	
Season Treatments		2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Control		85.00	91.50	17.50	18.67	27.50	29.50	68.60	72.50	8.31	8.21	7.20	7.50
Fe	0.05%	93.80	98.00	19.00	19.00	29.00	31.40	74.50	79.30	9.11	9.23	7.95	8.50
	0.08%	96.50	106.20	19.50	20.00	31.50	31.40	79.60	85.10	9.52	9.81	8.00	8.85
	0.1 %	99.00	108.00	20.00	20.00	32.60	33.45	82.10	89.20	9.98	9.88	8.75	9.00
Zn	0.05%	96.00	105.50	20.00	20.80	32.00	32.50	79.20	82.50	9.33	9.30	8.00	8.50
	0.08%	107.0	113.00	21.00	21.50	32.80	35.10	88.30	87.20	9.85	9.88	9.75	9.50
	0.1 %	111.0	117.00	21.00	21.67	34.00	36.20	95.60	96.70	10.21	10.08	10.00	10.00
Mn	0.05%	88.00	100.00	18.00	18.67	30.00	31.00	79.00	81.20	8.95	8.99	7.50	7.80
	0.08%	92.50	104.30	18.50	19.00	30.00	31.08	83.50	85.20	8.99	9.12	8.00	8.65
	0.1 %	94.60	106.10	18.80	19.50	32.00	33.60	89.90	94.80	9.38	9.42	9.85	9.45
Fe+Zn+Mn (0.05)		115.0	117.0	21.50	20.00	36.50	35.60	106.70	110.2	10.21	10.52	11.40	9.90
Fe+Zn+Mn (0.08)		119.40	119.00	22.50	21.00	37.80	36.00	111.50	114.10	10.88	10.59	11.50	10.80
Fe+Zn+Mn (0.1)		123.70	125.30	23.00	21.00	40.00	40.90	118.40	121.30	11.25	11.09	12.67	11.95
L.S.D.5%		5.51	5.62	1.91	1.94	1.25	1.56	6.21	6.98	0.59	0.62	1.2	1.23

The beneficial effect of spraying cotton plants with micronutrients on growth parameters might be mainly due to iron as it is indispensable for the synthesis of chlorophyll in green plants and as a part of the prophyrin compounds, cytochrom enzyme system (Ferry and Ward, 1969 and Amberger, 1974). Also, Zn is necessary in the synthesis of indole acetic acid, which is an important growth hormone in plant growth (Mayer and Anderson, 1972). Concerning Mn it acts as an activators of many enzymes and it is essential for formation of chlorophyli (Pandy and Sinha, 1978) . Yu *et al.* (1999) who reported that the beneficial effect

of the nutrients on plant growth related to their role, since they acted like plant growth hormones inducing the building of new meristematic cells and enhancing cell elongation and the ability rate of wheat leaves for photosynthetic process.

These findings are in general agreement with those obtained by Girgis, (1992); Wahdan *et al.*(1994); El- Kashlan *et al* .(1995); Abd El-Shafy, (1998); Badr *et al.* (1998); Darwish and Hegab, (2000); Salem and Mohmed (2000); Wassel *et al.* (2000); and Abd El-Shafy, *et al* . (2001) .

2- Yield and its components:-

Data listed in Table (3) reveal that the yield and its components of cotton plants significantly increased by increasing the rates of Fe, Zn or Mn in first season compared with the control plants. Best results were obtained with the rate of 0.1 % for each element, an increase of, 14.29, 13.71 and 8.00 % for average number of bolls / plant; 45.28, 22.32 and 30.36 % for average number of open bolls / plant; 19.50,19.00 and 12.50 % for average weight of dry open boll; 30.81, 36.73 and 27.14 % for average weight of seeds / plant and 28.49 and 28.45, 34.57 and 27.16 % for average seed cotton yield / fed., was observed .

The yield and its components of cotton plants were increased by increasing the rates of combination between Fe, Zn and Mn from the rates of 0.05, 0.08 to 0.1 %. The increments were, 17.71, 21.14 and 28.57 % for average number of bolls / plant; 47.32, 58.04 and 69.64 % for average number of open bolls / plant; 20.50, 24.50 and 26.50 % for average weight of dry open boll; 31.08, 39.36 and 47.83 % for average weight of seeds / plant and 43.96, 53.45 and 65.52 % for average seed cotton yield / fed., respectively, for the three rates, previously mentioned consequently at first season compared with the control. A similar trend was observed in the second season.

The positive effect of Fe, Zn and Mn application on the cotton yield and its components may be attributed to enhancing vigorous growth (especially number and area of leaves) and thereby, increased the synthesis of organic compounds, i.e. proteins, carbohydrates, amino acids and chlorophylls, that reflect on cotton plant yield and its components i.e number of open bolls / plant; weight of boll and yield of seed cotton / plant .

Also, the effect of micronutrients on plant growth may be attributed to their role in transmission of electron from water to chlorophyll and producing oxygen gas in the photosynthesis, in addition to their role in the nitrogen metabolic through activated nitrite ruductase enzyme (Baza, 1981). Also, El-Hamawi (1977) attributed the good effect of foliar spraying with trace elements on average number of bolls / plant; average number of open bolls / plant; average weight of boll and average yield of seed cotton / fed. to the role of trace elements on fundamental metabolic reactions and accelerating protein synthesis which affects boll development and formation All these results are in harmony with those of Ziadah, (1991); Girgis, (1992); Girgis *et al.* (1993); Wahdan *et al.*(1994); El- Kashlan *et al* .(1995); Abd El-Shafy, (1998); Badr *et al.* (1998); Darwish and Hegab, (2000); Salem and Mohmed (2000); Wassel *et al.* (2000); Abd El-Shafy *et al* . (2001) and El-Yazal- Sawsan, and El-Sayim (2004) .

Table (3): Effect of solely and combined application of Fe, Zn and Mn on cotton yield and its components grown in newly reclaimed sandy soil.

Characters		Av. number of bolls / plant		Av. number of open bolls / plant		Av. boll weight (g)		Av. seeds yield / plant		Av. seed cotton yield / plant	
Season Treatments		2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Control		17.50	18.60	11.20	12.00	2.00	2.09	15.22	15.52	1160	1225
Fe	0.05%	18.80	19.00	11.90	12.80	2.10	2.17	16.85	16.99	1285	1380
	0.08%	19.30	19.70	12.50	13.00	2.22	2.22	18.50	18.75	1375	1400
	0.1 %	20.00	20.00	12.80	13.70	2.39	2.45	19.91	20.60	1490	1526
Zn	0.05%	19.00	19.30	12.50	12.40	2.15	2.18	18.95	19.00	1415	1445
	0.08%	19.00	19.50	13.40	13.00	2.21	2.24	20.52	20.00	1525	1478
	0.1 %	19.90	20.50	13.70	13.50	2.38	2.36	20.81	21.45	1561	1640
Mn	0.05%	17.80	18.80	12.80	13.20	2.10	2.12	16.00	16.55	1285	1297
	0.08%	18.50	19.30	13.81	13.60	2.15	2.18	17.63	17.50	1340	1386
	0.1 %	18.90	19.60	14.60	14.90	2.25	2.27	19.35	19.00	1475	1499
Fe+Zn+Mn (0.05)		20.60	21.40	16.50	16.80	2.41	2.44	19.95	20.50	1670	1692
Fe+Zn+Mn (0.08)		21.20	21.70	17.70	17.50	2.49	2.47	21.21	21.40	1780	1794
Fe+Zn+Mn (0.1)		22.50	21.90	19.00	19.10	2.53	2.55	22.50	23.30	1920	1900
L.S.D. 5 %		0.40	0.55	0.63	0.66	0.04	0.06	1.28	1.33	58.00	51.90

3- Chemical constituents:_-

3-1- N, P, K, Fe, Zn and Mn concentrations in leaves:

Data presented in Table (4) show that the foliar spraying plants with the highest rates of Fe (0.1 %) significantly increased the concentrations of N, P, K, Fe, Zn and Mn in the dry leaves of cotton plants. The increments revealed, 10.85, 21.05, 32.50, 73.24, 48.8 and 44.86 %, respectively. The same trend existed obtained by applying Zn or Mn alone at the same rate (0.1 %), being, 16.74 and 9.05 %; 31.58 and 31.58 %;43.33 and 52.50 %; 47.89 and 35.49 %; 171.76 and 28.24 % and 59.46 and 112.4 %, respectively .

The concentrations of N, P, K, Fe, Zn and Mn in dry leaves of cotton plants were affected greatly by the combination of the three elements, especially with the highest rate of (0.1 %) . The percentages of increase were, 28.05, 57.89, 68.33, 119.15, 204.58 and 169.20 %, respectively, at the first season compared with the untreated plants . The same trend was observed in the second season.

Increasing N, P, K, Fe, Zn and Mn concentrations in dry leaves of cotton plants due to foliar spraying of micronutrients may be attributed to their role in increasing plant capacity to absorb nutrients, which increased root surface per soil volume unit, in addition to the high capacity of the plants supplied with micronutrients in building metabolites, which in turn greatiy contribute in the increase of nutrients uptake .

Table (4): Effect of solely and combined application of Fe, Zn and Mn on concentrations and total uptake of N, P, K, Fe, Zn and Mn of cotton plants grown in newly reclaimed sandy soil.

Characters		N %		P %		K %		Fe (mg / g D.W.)		Zn (mg / g D.W.)		Mn (mg / g D.W.)	
Season / Treatments		2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Control		2.21	2.26	0.19	0.20	1.20	1.25	3.55	4.22	1.31	1.35	1.85	2.00
Fe	0.05%	2.31	2.38	0.21	0.23	1.32	1.40	5.48	5.95	1.61	1.59	2.18	2.23
	0.08%	2.33	2.39	0.21	0.24	1.49	1.52	5.97	6.42	1.83	1.86	2.29	2.35
	0.1 %	2.45	2.48	0.23	0.25	1.59	1.65	6.15	6.53	1.95	1.96	2.68	2.61
Zn	0.05%	2.38	2.41	0.22	0.23	1.31	1.42	4.00	4.65	2.35	2.54	1.95	2.18
	0.08%	2.48	2.52	0.24	0.23	1.41	1.52	4.86	4.97	3.19	3.58	1.99	2.20
	0.1 %	2.58	2.68	0.25	0.26	1.72	1.82	5.25	5.39	3.56	3.50	2.95	2.85
Mn	0.05%	2.27	2.29	0.23	0.22	1.62	1.81	3.91	3.98	1.38	1.48	3.25	3.15
	0.08%	2.35	2.33	0.24	0.24	1.71	1.93	4.16	4.29	1.51	1.55	3.48	3.29
	0.1 %	2.41	2.41	0.25	0.26	1.83	1.95	4.81	4.95	1.68	1.56	3.93	3.50
Fe+Zn+Mn (0.05)		2.69	2.73	0.26	0.27	1.91	1.97	6.25	6.91	3.92	3.69	4.21	4.39
Fe+Zn+Mn (0.08)		2.75	2.79	0.28	0.29	1.95	1.98	7.52	7.59	3.95	3.74	4.86	4.95
Fe+Zn+Mn (0.1)		2.83	2.89	0.30	0.32	2.02	2.15	7.78	7.75	3.99	3.95	4.98	5.12
L.S.D. 5 %		0.08	0.10	0.03	0.03	0.22	0.24	1.02	1.09	0.55	0.61	0.16	0.19

3-2- Total carbohydrates, total chlorophylls and carotenoids concentrations in leaves:-

Data in Table (5) show that spraying cotton plants with Fe, Zn and Mn either alone or in combination significantly increased organic compounds such as total carbohydrates, total chlorophylls and carotenoids concentrations in leaves at the first season compared with the untreated plants especially at the highest rate of 0.1 % . The increments resulting by the application of Fe, Zn or Mn were, 32.70, 39.58 and 31.94 % for total carbohydrates; 53.63, 56.26 and 50.55 % for total chlorophylls and 40.00, 64.57 and 26.29 % for carotenoids concentrations, respectively. A combination of Fe, Zn and Mn nutrients (especially at rate of 0.1 %), also, greatly increased the total carbohydrates (71.90 %), total chlorophylls (95.82 %) and carotenoids (98.86 %) concentrations in leaves (especially at the highest rate of 0.1 %) at the first season compared with the untreated plants.

It is well known that Fe is essential for chlorophyll synthesis, Zn and Mn are involved in several enzymes attributed to carbohydrate and protein metabolism and also comes through the synthesis of indole acetic acid (Zn) (Hearn, 1981) . Ahmed (1977) reported that chloroplast pigments contents in cotton leaves increased by application of Fe, Mn and Zn .

3-3- Crude proteins and oil concentrations in seeds:

Data presented in Table (5) indicated that both crude protein and oil concentrations in cotton seeds were increased by increasing the rate of Fe, Zn and Mn application each alone, especially at the highest rate of 0.1 %,being, 12.17 and 12.60 %; 15.94 and 21.67 % and 10.14 and 16.01%, respectively and consequently, at the first season as compared to the untreated plants .

Table (5): Effect of solely and combined application of Fe, Zn and Mn on total carbohydrates, total chlorophyll, carotenoids, seed crude protein and seed oil of cotton plants grown in newly reclaimed sandy soil.

Characters		Total carbohydrates % in leaves		Total chlorophyll % in leaves		Carotenoids % in leaves		Seed crude protein %		Seed oil %	
Season Treatments		2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Control		26.30	26.95	4.55	4.86	1.75	1.85	17.25	18.21	15.00	15.51
Fe	0.05%	28.21	28.50	5.98	6.10	2.18	2.20	17.88	18.68	16.21	16.32
	0.08%	32.61	33.42	6.31	6.38	2.35	2.33	18.33	18.85	16.49	16.52
	0.1 %	34.90	34.32	6.99	6.86	2.45	2.49	19.94	19.00	16.89	16.94
Zn	0.05%	29.22	30.60	6.15	6.21	2.22	2.24	18.45	19.09	17.31	17.85
	0.08%	32.90	33.80	6.82	6.95	2.33	2.36	19.21	19.79	16.75	16.99
	0.1 %	36.71	36.83	7.11	7.31	2.88	2.50	20.00	20.45	19.25	17.82
Mn	0.05%	29.00	29.09	5.82	5.73	2.00	2.08	18.00	18.35	16.73	16.78
	0.08%	30.15	31.21	5.93	5.97	2.09	2.12	18.68	18.83	16.80	16.98
	0.1 %	34.70	35.02	6.25	6.22	2.21	2.28	19.00	19.15	17.41	17.68
Fe+Zn+Mn (0.05)		37.25	39.20	7.85	7.94	3.03	2.58	20.89	21.00	19.81	18.76
Fe+Zn+Mn (0.08)		40.00	43.50	8.12	8.28	3.16	2.80	21.81	21.93	19.91	19.91
Fe+Zn+Mn (0.1)		45.21	46.81	8.19	8.96	3.48	3.00	22.10	22.75	21.30	20.21
L.S.D. 5 %		1.56	1.65	1.31	1.42	0.11	0.15	0.09	0.12	0.63	0.69

A significant increase in crude proteins and edible oil concentrations in cotton seeds was obtained by the treatment of Fe, Zn and Mn nutrients at the rates of 0.05, .08 and 0.1 %, attained, 21.10 and 32.07 %; 26.43 and 32.73 % and 28.12 and 42.00 %, respectively, at the first season as compared to the control plants . Similar trend was noticed at the second season .

The positive effect of Fe, Zn and Mn application on chemical constituents of cotton plants may be attributed to enhancing vigorous growth (especially leaves number and area) and hence, increasing organic compounds synthesis, i.e. proteins, carbohydrates, amino acids and chlorophylls.

The results showed that micronutrients play an important role in formation of crude proteins and oil concentrations in seeds, where Fe, Zn and Mn share in reduction of nitrates and sulphates, protein synthesis and perform important functions in metabolism (Hearn, 1981) .

In general these results are in agreement with those reported by Girgis, (1992); Wahdan *et al.*(1994); El- Kashlan *et al* .(1995); Abd El-Shafy, (1998); Badr *et al.* (1998); Darwish and Hegab, (2000); Salem and Mohmed (2000); Wassel *et al.* (2000); and Abd El-Shafy *et al* . (2001) on cotton plants; El-Yazal-Sawsan and El-Sayim (2004) on wheat plants; Mohamed *et al* . (2000) on black cumin and Mohamed *et al* . (2001) on Roselle plants .

4 -Anatomical studies:

4 -1- Stem structure:

It is clear from the data in Table (6) and Figure (1) that treated plants with micronutrients (Fe, Mn and Zn at the rates of 0.05, 0.08 and 0.1 % for each element) either alone or in combination had a stimulative effect on the structure of stem tissues especially at the highest rate (0.1 % . Plants treated with the Mn element alone showed a better affect than that at Fe or Zn . The best recorded results of the stem tissues were obtained by the treatment Fe + Mn + Zn at the highest rate (0.1 %) followed by the treatment Fe + Mn + Zn at the rate (0.08 %). the increments were, 40.0 and 36.2 % in section diameter; 33.3 and 183.3 % in average cortex thickness; 12.5 and 75 % in number of cortical layers; 18.1 and 52.1 % in average diameter of cortical cells; 75 and 25 % in average vascular cylinder thickness,; 106.3 and 35 % in average number of xylem vessels; in average diameter of metaxylem vessel; 24.3 and 16.2 % in average pith thickness; 20.0 and 14.3 % in average number of pith layers and 9.5 and 7.6 % in average diameter of pith cells, respectively, compared with the untreated plants .

4 -2- Leaf structure:

Data presented in Table (7) and Figure (2) show that the foliar spraying of cotton plants with micronutrients (Fe, Mn and Zn) even alone or in combination had a stimulative effect on leaf blade tissues . The high levels of micronutrients (0.1 %) clearly increased leaf tissues and the arrangement of leaf blade tissues was as follow: Mn > Zn > Fe . The combination of the three elements showed better effect on leaf blade tissues especially at the rates of 0.1 % then 0.08 %, the increase reached, 44.4 and 40.0 % in medvein thickness;81.8 and 72.7% in lamina thickness; 100 and 100 % palisade tissues thickness; 100 and 71.4 % for spongy tissues thickness; 86.7 and 66.7 % in length and 68.0 and 80.0 % in width of vascular bundle; 96.2 and 84.6 % in number of xylem vessels and 35 % for average diameter of metaxylem vessels, respectively, comparing with the control plants .

The stimulative effect of micronutrients (Fe, Mn and Zn) applied either alone or in combination on cotton stem or leaf blade tissues may be due to the role of micronutrients as co-factors for many enzymes included metabolic processes and synthesis of auxins, which stimulate cell division and expansion.

The stimulative role of micronutrients on several plants was reported by Mohamed, (1989) on chamomile and fennel plants and Mohamed *et al.*, (2001) on roselle plants .

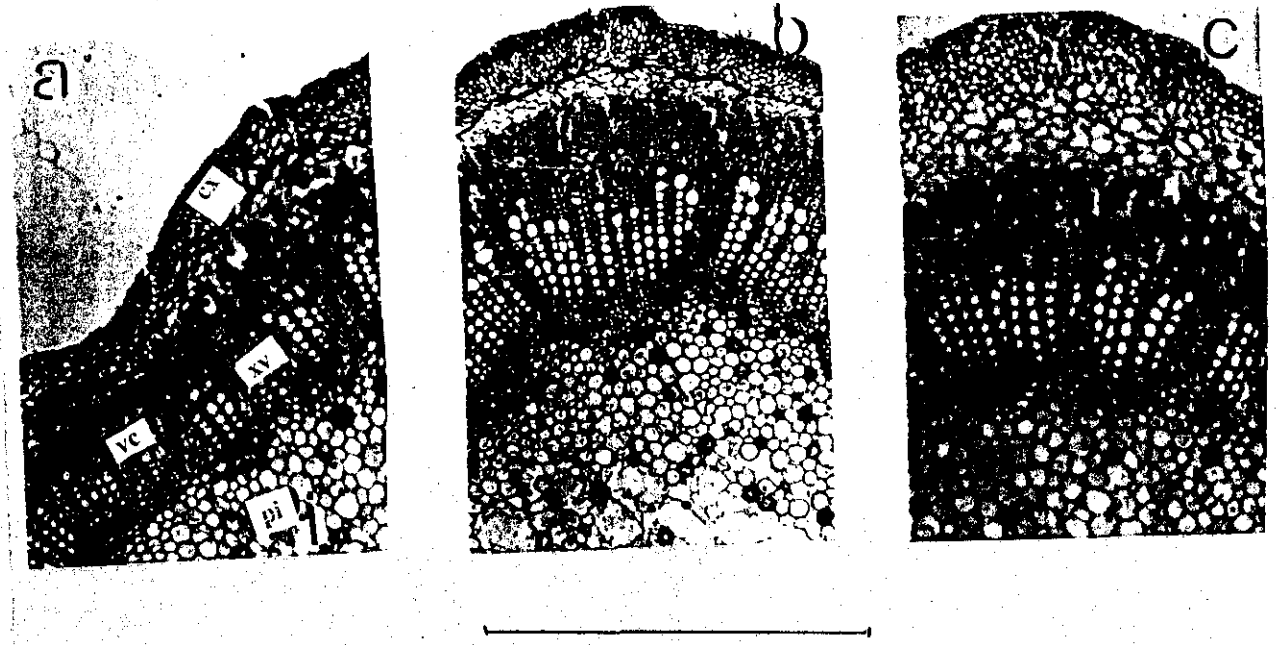

Figure (1): Transections of stem cotton plant (7 th internode) as affected by Fe , Mn and Zn and their interactions.

(ex = cortex, pi = pith , vc = vascular cylinder and xv = xylem vessel)

a- control treatment (tap water). b- The treatment, Fe (0.1 %) c- The treatment, Zn (0.1%).

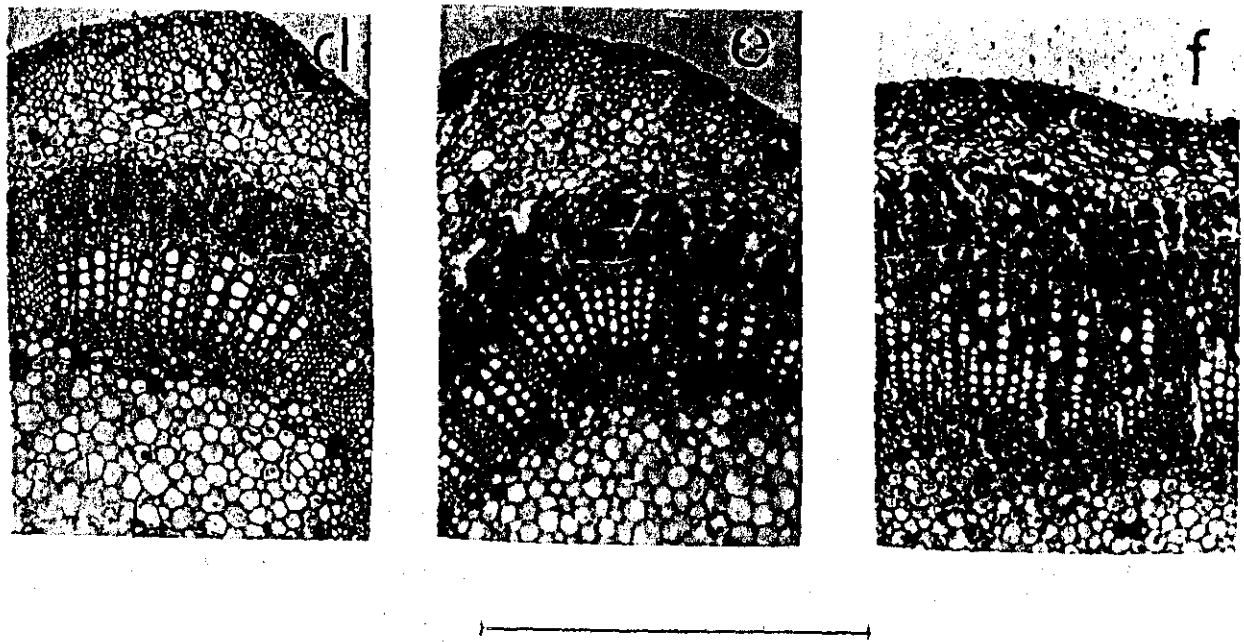

Figure (1): Cont .

d- The treatment Mn (0.1%) . e- The treatment Fe + Mn + Zn (0.08%) . f- The treatment Fe + Mn + Zn (0. 1%)

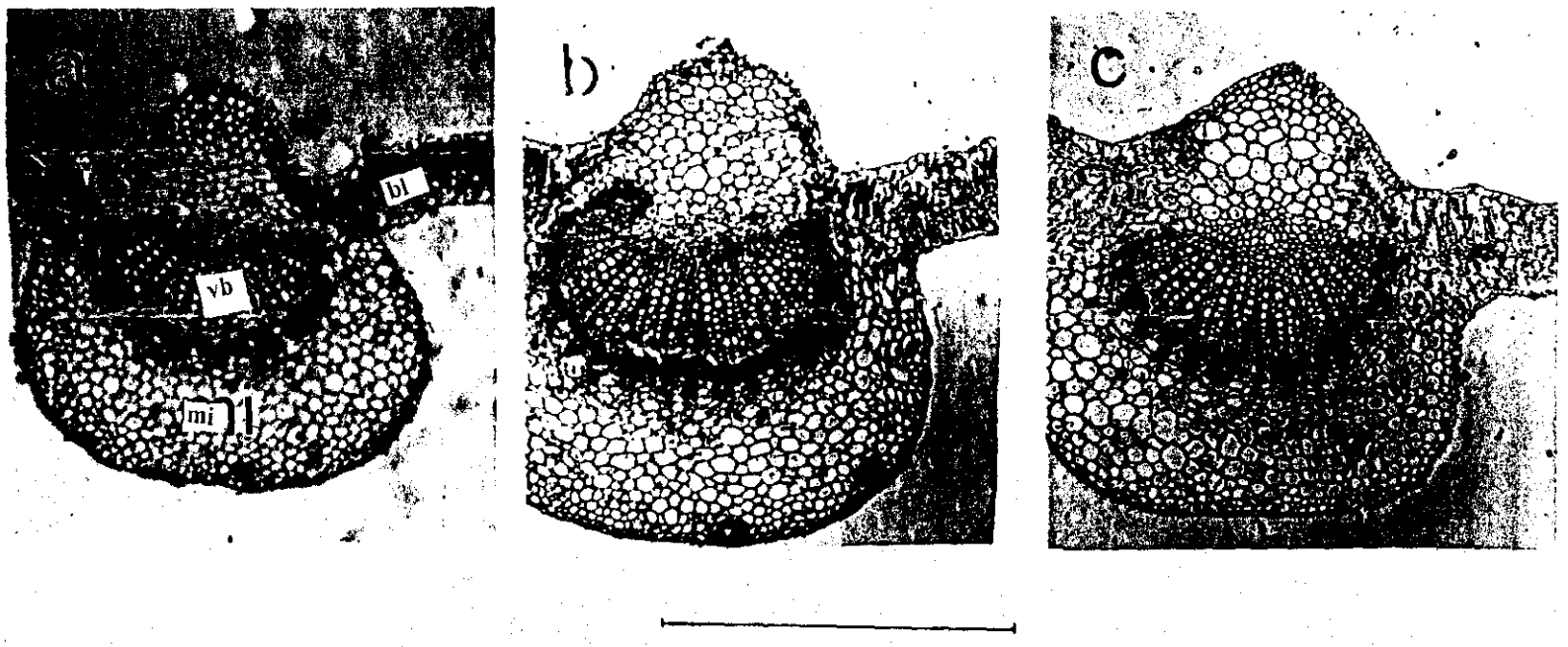

Figure (2): Transections of leaf cotton plant (7 th leaf) as affected by Fe , Mn and Zn and their interactions.

(mi = midvein , vb = vascular bundle and bl = blade)

a- control treatment (tap water). b- The treatment, Fe (0.1 %). c- The treatment, Zn (0.1%)

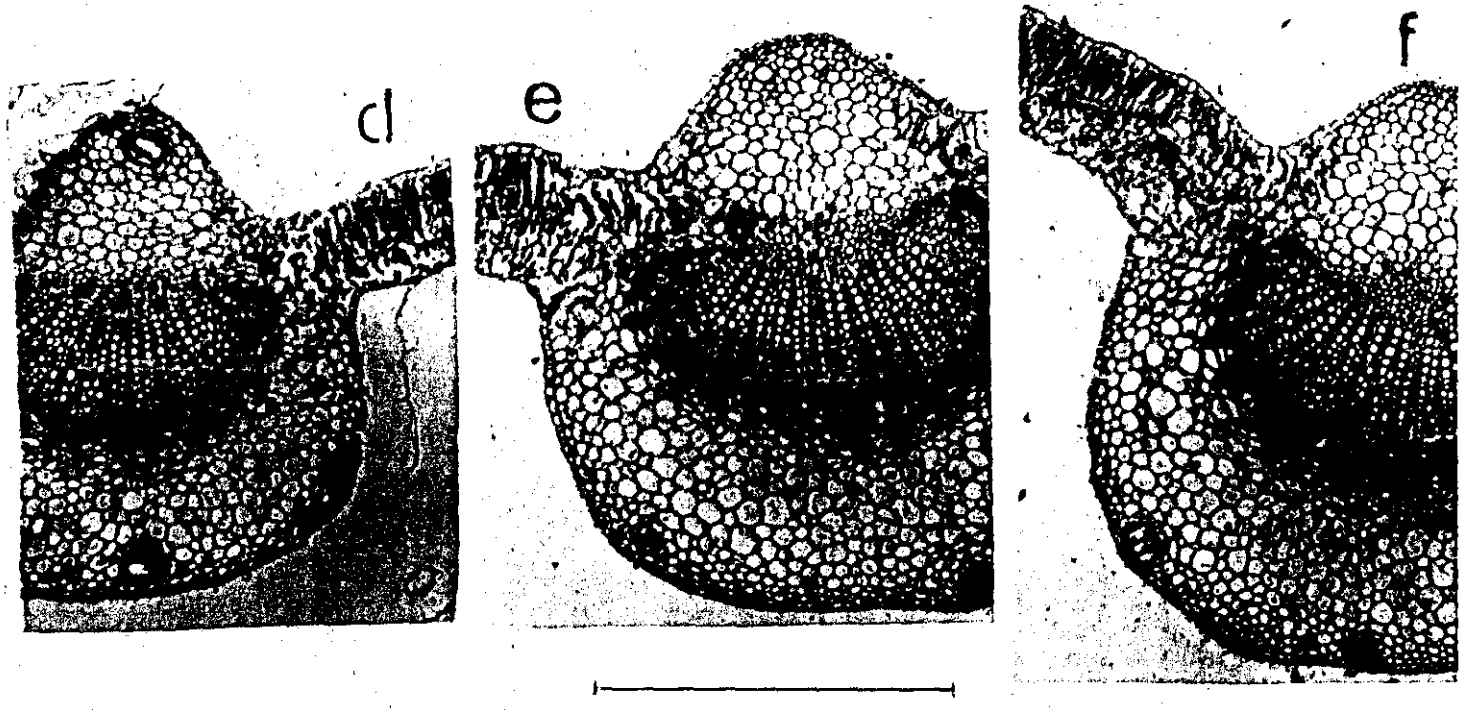

Figure (2): Cont .

d- The treatment Mn(0.1%) . e- The treatment Fe + Mn + Zn (0.08%) . f- The treatment Fe + Mn + Zn (0. 1%)

Table (6.): Anatomical observations on cotton stem plant grown in newly reclaimed soil affected by micronutrients application .

Characters / Treatments	Section diameter μ	Cortex thickness μ	No. of cortical layers	Av. diameter of cortical cell μ	Av. of vascular cylinder thickness μ	Av. Number of vessel / 1000 μ	Av. diameter of metaxylem vessel μ	Av. Pith thickness μ	Av. Number of Pith layers	Av. diameter of pith cell μ
Control	3000	150	8	18.8	400	60	26	1850	35	52.9
Fe (0.1%)	3500	200	10	20.0	550	150	28	1980	37	53.5
Zn (0.1%)	3900	350	14	25.0	575	102	28	1990	36	55.3
Mn(0.1%)	3985	400	14	28.6	500	108	26	2000	36	55.6
Fe+Mn+Zn (0.08%)	4085	425	14	30.7	575	80	30	2150	40	53.8
Fe+Mn+Zn (0.1%)	4200	225	9	25.0	680	200	30	2300	42	54.8

Av. = Average

Table (7): Anatomical observations on cotton leaf tissues grown in newly reclaimed soil affected by micronutrients application.

Characters / Treatments	Midvein thickness	Blade thickness μ	Palisade tissue thickness μ	Spongy tissue thickness μ	Dimensions of vascular bundle μ		Av. number of xylem vessels	Av. diameter of metaxylem vessel μ
					length	width		
Control	1125	225	100	75	375	625	130	20
Fe (0.1%)	1250	270	125	80	400	900	238	22
Zn (0.1%)	1275	290	125	100	400	775	150	24
Mn(0.1%)	1350	300	140	120	500	850	216	25
Fe+Mn+Zn(0.08 %)	1575	380	190	130	625	1125	240	27
Fe+Mn+Zn (0.1%)	1625	400	200	140	700	1050	268	27

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تأثير الرش ببعض العناصر الصغرى على النمو والمحصول والمكونات الكيميائية والتركيب التشريحى لنباتات القطن النامية فى أرض مستصلحة حديثا

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فى تجربة حقلية نفذت خلال الموسمين ٢٠٠٢ و ٢٠٠٣ لدراسة تأثير الرش ببعض العناصر الصغرى (الحديد ، والزنك ، المنجنيز) سواء منفردة أو مشتركة معا بالمعدلات ٠,٠٥ ، ٠,٠٨ ، ٠,١ % على النمو الخضري والمحصول والتركيب الكيماوي والتركيب التشريحي لنباتات القطن (صنف جيزة ٧٠) النامية تحت ظروف الأرض المستصلحة حديثا ٠

وقد أظهرت النتائج أن زيادة معدل إضافة عناصر الحديد والزنك والمنجنيز سواء منفردة أو مجتمعة قد أظهرت تأثيرات إيجابية إذ أنها سـببت زيادة في ارتفاع النبات ، عدد الأوراق / النبات ، عدد السلاميات / الساق الرئيسية ، مسـاحة الورقة ، عدد الأفرع الثمرية / نبات ، الوزن الجاف للأوراق / نبات في حالة النمو الخضرى ، بالأضافة إلى زيادة فى عدد اللوز / نبات ، عدد اللوز المتفتح / نبات ، متوسط وزن اللوزة / نبات ، وزن محصول البذرة للنبات ،وزن محصول القطن الزهر / الفدان في مرحلة النضج وما بعده ومثل هذه البحوث تفتح الطريق لزراعة القطن بهذه الأراضى المستصلحة حديثا ٠

لوحظ نفس الاتجاه تقريبا بالنسبة لمحتوى النبات من المكونات الكيميائية حيث زاد محتوى الأوراق من النيتروجين ، الفوسفور، البوتاسيوم ، الحديد ، الزنك ، المنجنيز، الكربوهيدرات الكلية ، الكلورفيلات الكلية ،الكاروتينات ٠ كما زادت نسبة البروتين الخام والزيت بالبذور ٠

فيما يتعلق بتأثير العناصر الصغرى على التركيب التشريحي لساق وورقة نبات القطن فأن النتائج قد اوضحت ان هناك تأثير إيجابي للرش بتلك المغذيات علي كل الصفات التي تم دراسـتها ٠

عموما فأن أفضل نتائج التجربة تم الحصول عليها نتيجة الرش بالمعاملة المشتركة لعناصر الحديد ، الزنك ، المنجنيز وخاصة عند أعلى معدل إضافة (٠,١ %) ولذلك يمكن التوصية برش نباتات القطن النامية تحت ظروف الأراضى المستصلحة حديثا بالعناصر الصغرى مجتمعة بنسبة (٠,١%) وذلك للحصول على محصول أفضل