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EFFECT OF MANURING WITH DIFFERENT LEVELS OF ORGANIC FERTILIZER WITH AND WITHOUT FERRUS SULPHATE OR ZINC SULPHATE ON SOIL NUTRIENTS AVAILABILITY TO WHEAT PLANTS

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ABSTRACT

A pot experiment was conducted in the greenhouse of the Programme "Micronutrient and Other Plant Nutrition Problems in Egypt" with wheat plants to study the influence of manuring with different levels of Farm Yard Manure (FYM) alone or when enriched with $FeSO_4$ or $ZnSO_4$ on the dry matter formation, nutrient concentrations and nutrient uptake by the plants. The obtained data showed that there are positive correlations between the increased levels of organic manure and both uptake and dry matter formation by the plants. Enrichment with $FeSO_4$ or $ZnSO_4$ has additionally increased nutrient uptake, concentrations and dry weight of the plants and enrichment with $FeSO_4$ was the most effective. The treatments 1[0.25 % FYM (5 m^3/fed) + 0.35 g/pot $FeSO_4$ or $ZnSO_4$ (50 Kg/fed)] and 2 [0.50 % FYM (10 m^3/fed) + 0.35 g/pot $FeSO_4$ or $ZnSO_4$ (50 Kg/fed)] were the best. Negative correlations were recorded with dry weight, N, Ca, Mg and Mn uptake and increased levels of FYM in case of enrichment with $FeSO_4$, while negative correlations were only found in both Mg and Mn uptake in case of enrichment with $ZnSO_4$.

INTRODUCTION

In order to establish high crop yields, adequate amounts of plant nutrients must be available in the soil. Deficiency of one or more nutrient(s) becomes limiting factor(s) to achieve good yields (El-Fouly, 1983).

Addition of organic manure to the soil is known to improve soil structure and availability of nutrients to crops. Decomposition rate of organic matter, however, depends very much upon organic matter type and soil conditions (Sluijsmans and Kolenbrander, 1977). Farm Yard Manure (FYM) is considered to be the best organic manure in improving soil fertility and supplying of nutrients (Cooke, 1972). Raising soil fertility, it makes crop nutrient uptake ratios very closely to crop nutrient requirements (Kolenbrander, 1972).

Availability of nutrients to be taken up by the plant roots is also pH controlled (Schaller, 1987; Marschner and Roemheld, 1996). Supplying of micronutrients to the soil in acidic forms was found to improve nutrients availability to crops (Lindsay, 1974, Marschner, 1995).

The present work aimed at studying the effect of addition of FYM in different levels with and without iron-sulfate or zinc-sulfate to the soil on dry matter formation, nutrients concentrations and nutrient uptake by wheat plants.

MATERIALS AND METHODS

Plant material:

A pot experiment with wheat (*Triticum aestivum* L. cv. Giza 69) was carried out in the greenhouse of the Programme "Micronutrients and Other Plant Nutrition Problems in Egypt", National Research Centre, Dokki, Egypt. Seeds were sown in November in Mitscherlich pots containing 7.0 Kg soil.

Basic Fertilization:

Before sowing, each pot received 1.0 g superphosphate (15.5 % P_2O_5) and one third of 1.0 g potassium sulphate (48 % K_2O) + 2.0 g ammonium sulfate (20.6 % N). Two other splits of equal quantities of N and K were applied at 10 days after sowing and before tillering. At seedling stage, the plants of each pot were thinned to 10 plants.

Other practices:

Irrigation was applied to maintain the water level at 60 % of the field capacity. No pesticides were used during the course of the study.

Treatments:

The treatments were carried out in three replicates and conducted as follows:

Control: - Without Farm Yard Manure (FYM)
- Without FYM + 0.35 g/pot $FeSO_4$ (50 Kg/fed)
- Without FYM + 0.35 g/pot $ZnSO_4$ (50 Kg/fed)

- 0.25 % of soil weight FYM (5 m^3/fed)
- 0.25 % of soil weight FYM (5 m^3/fed) FYM + 0.35 g/pot $FeSO_4$ (50 Kg/fed)
- 0.25 % of soil weight FYM (5 m^3/fed) FYM + 0.35 g/pot $ZnSO_4$ (50 Kg/fed)

- 0.50 % of soil weight FYM (10 m^3/fed)
- 0.50 % of soil weight FYM (10 m^3/fed) FYM + 0.35 g/pot $FeSO_4$ (50 Kg/fed)
- 0.50 % of soil weight FYM (10 m^3/fed) FYM + 0.35 g/pot $ZnSO_4$ (50 Kg/fed)

- 0.75 % of soil weight FYM (15 m3/fed)
- 0.75 % of soil weight FYM (15 m^3/fed) FYM + 0.35 g/pot $FeSO_4$ (50 Kg/fed)
- 0.75 % of soil weight FYM (15 m^3/fed) FYM + 0.35 g/pot $ZnSO_4$ (50 Kg/fed)

- % of soil weight FYM (20 m3/fed)
- 1.0 % of soil weight FYM (20 m^3/fed) FYM + 0.35 g/pot $FeSO_4$ (50 Kg/fed)
- 1.0 % of soil weight FYM (20 m^3/fed) FYM + 0.35 g/pot $ZnSO_4$ (50 Kg/fed)

Sampling and sample analysis

- **oil and FYM samples**: a representative soil sample was taken after soil preparation but before fertilization. A sample was also taken from the ground manure. The samples were air-dried. Soil samples passed through a 2.0 mm sieve pores. Mechanical analysis of soil samples was carried

out using hydrometer method (Bauyoucos, 1954); pH and E.C (electric conductivity) were determined in soil/water or manure/water extract (1:2.5) (Jakson, 1973); Calcium carbonate ($CaCO_3$) content of the soil was determined using Calcimeter method (Black, 1965); Organic matter (O.M.) was determined using potassium dichromate method (Walkely and Black, 1934)

Total nitrogen was determined using Bauschi digestion and distillation apparatus. Soil and manure phosphorus was extracted using sodium bicarbonate (Olsen *et al*., 1954). Potassium (K) and magnesium (Mg) were extracted using ammonium acetate (Chapman and Pratt, 1978)., while Fe, Mn, Zn and Cu were extracted using DTPA (Lindsay and Norvell, 1978). Physical characteristics and nutrient contents of soil and FYM are shown in Tables 1&2, respectively.

Soil nutrient status was evaluated according to the sufficient concentrations of Ankerman and Large (1974) as follows:

Element	**P**	**K**	**Mg**	**Fe**	**Mn**	**Zn**	**Cu**
	-------- mg/100 g soil ----------			---------- ppm ----------			
Concentration	1.2-2.7	21-30	30-180	11-16	9.0-12	1.6-3.0	0.9-1.20

Table 1: Mean values of physical and chemical soil characteristics

Physical characteristics		**Nutrient concentrations**	
		Exchangeable Macronutrients	
		(mg/100g soil)	
Ph	8.3		
E.C. (dS/m)	0.8	P	5.2*
$CaCO_3$ (%)	1.6	K	37.9*
O.M. (%)	0.1	Mg	30.7*
Sand (%)	13.8	***Available Micronutrients***	
Silt (%)	28.0	**(mg/Kg soil)**	
Clay (%)	58.2	Fe	2.8***
Texture	Clay Loam	Mn	5.9**
		Zn	3.3*
		Cu	10.2*

*** Adequate** **** Low** ***** Very low**

Table 2: Mean values of physical and chemical FYM characteristics

Physical characteristics		**Nutrient concentrations**	
		Exchangeable Macronutrients	
		(%)	
PH	8.8	N	1.6
E.C. (dS/m)	8.9	P	0.64
O.M. (%)	32.8	K	1.87
		Mg	0.5
		Na	0.84
		Available Micronutrients	
		(mg/Kg manure)	
		Fe	3143
		Mn	349
		Zn	140
		Cu	48

***Plant samples**:

The plants were harvested at 70 days age. Plants of every replicate were washed with tap water, 0.01 N HCl and bidistilled water, sequentially, oven dried at 70°C for 24 hours and ground. Plant material was dry-ashed in a

muffle furnace at 550°C for 6 hours using 3.0 N HNO_3. The residue was, then suspended in 0.3 N HCl.

Nitrogen was determined using Bauschi digestion and distillation apparatus. Phosphorus was photometrically determined using a Spectrophotometer. K and Ca were measured using Dr. Lang Flamephotometer. Mg, Fe, Mn, Zn and Cu were determined using Atomic Absorption Spectrophotometer.

Dry weight determination:

The samples were weighed (gm) and oven dried at 70° C for 24 hours, then weighed again and the dry weight was calculated.

Data analysis

Data were statistically analyzed using Costate Statistical Package (Anonymous, 1989).

RESULTS AND DISCUSSION

Dry matter formation:

Addition of the farm yard manure alone at all levels was found to increase the dry matter formation by wheat plants (Fig. 1). Moreover, enriching of the organic matter with $FeSO_4$ or $ZnSO_4$ realized additional increments in the dry matter. It can be also observed that the treatments 1) and 2) are the most effective in this respect and increasing of the FYM ratio led to less effect especially in case of the enrichment with $FeSO_4$ or $ZnSO_4$ which is clearly presented in treatment 4). A positive correlation of 0.55 was found in case of addition of FYM alone, and 0.47 in case of FYM+$ZnSO_4$ while it was negative (-0.16) in case of FYM+$FeSO_4$. Similar results were obtained by Ramadan *et al*. (1989) with organic manure. Decrease of biomass formation by the plants with ratio increment of the organic manure enriched with $FeSO_4$ or $ZnSO_4$ may attributed to the interruption in the uptake of one or more of the nutrients by the plant roots. Interruption may be because of reducing the availability of one or more nutrient(s) or creating nutrient unbalance in the root zone. This can clearly be shown from the elements concentrations in the plant tissues.

Fig. 1: Dry weight of wheat plants as affected by different levels of FYM alone or when enriched with $FeSO_4$ or $ZnSO_4$.

Nutrient concentrations:

Addition of FYM alone was less effective in raising nitrogen concentration in the plant tissues (Fig. 2). Low levels of organic manure enriched with $FeSO_4$ or $ZnSO_4$ [treatments 1) and 2)] increased N, P, K and Ca concentrations compared to control plants. Increasing of the organic manure ratio in the soil enriched with $FeSO_4$ or $ZnSO_4$ [Treatments 3) and 4)] was found to decrease the macronutrients N, P, Mg and Ca concentrations. As the organic matter ratio increased, may these elements -in the presence of Fe or Zn- form complexes unavailable to be taken up by the roots (Mengel and Kirkby, 1987). Addition of Fe or Zn in the sulfate form my lower pH and, hence, gave rise to more availability of micronutrients (Lucas and Kenezek, 1972) (Fig. 3). However, the high ratio of the organic matter may adsorb some of them causing retardation in their availability. It is also, clear from Fig. 3 that Zn addition raised the concentration of Fe, while addition of Fe dramatically lowered Mn-concentration in the plant tissues.

Fig. 2: Macronutrient concentrations (%) in wheat plant tissues as affected by FYM levels alone and when enriched with $FeSO_4$ or Zn SO_4.

Fig. 3: Micronutrient concentrations (ppm) in wheat plant tissues as affected by FYM levels alone and when enriched with $FeSO_4$ or Zn SO_4

Similar results were reported by Foy *et al*.(1978). Both Fe and Zn were found to antagonize with Cu concentration and the effect became less as the ratio of organic manure increased in case of Zn-enrichment. This may also be attributed to the degree of nutrients adsorption by high concentrations of soil organic matter (Mengel and Kirkby, 1987).

Nutrients uptake:

The picture may become clear with looking to nutrients uptake by wheat plants. Positive correlations were found between all determined macronutrients uptake and addition of FYM (Table 3) and, also, all determined micronutrients uptake and addition of FYM except with iron (Table 4).

Increase of nutrients uptake related to their availability increase can be attributed to changes in rhizosphere conditions which give rise to excretion of organic acids from the roots and evolution of CO_2 from the organic carbon (Marschner and Roemheld, 1996). The highest uptake of macro- and micronutrients was frequently found with the treatment 2) and enrichment with $FeSO_4$ or $ZnSO_4$ was found to, additionally, increase their uptake. Ca, Mg and Mn uptakes were found to be negatively correlate with FYM ratio increase in the soil in case of $FeSO_4$ enrichment. Similar trend was found in Mg and Mn uptake in case with $ZnSO_4$ enrichment. This can be explained by the antagonism between iron or zinc and these elements (Marschner and Roemheld, 1996; Walter *et al*., 1994). This also may be due to the complexes of these nutrients formed by increasing of the organic manure levels, which have high stability constants rendering less availability of such elements for plant uptake.

Table 3: Uptake of macronutrients by wheat plants as affected by the increased ratios of organic manure with and without $FeSO_4$ or $ZnSO_4$

Treatment	O.M effect		O.M + $FeSO_4$ effect			O.M + $ZnSO_4$ effect		
	Uptake mg/pot)	Uptake increase (%)	Uptake (mg/ pot)	*O.M effect (uptake increase %)	**$FeSO_4$ effect (uptake increase %)	Uptake (mg/pot)	*O.M effect (uptake increase %)	**$ZnSO_4$ effect (uptake increase %)
Nitrogen (N)								
Control	228.0	--	391.1	--	71.5	246.1	--	7.93
1	314.5	37.9	514.1	31.4	63.4	513.7	108.7	63.3
2	287.6	26.1	536.5	37.1	86.5	560.2	127.6	94.8
3	310.5	36.1	462.6	18.3	48.9	470.9	91.3	51.6
4	291.2	27.7	392.6	0.4	34.8	428.6	74.1	47.2
Mean	286.3	--	459.3	--	--	443.9	**--**	**--**
±SD	34.6	--	67.2	--	--	120.9	**--**	**--**
r	0.55	--	- 0.12	--	--	0.41	**--**	**--**
Phosphorus (P)								
Control	44.1	--	63.4	--	43.8	49.2	--	12.0
1	77.0	74.6	92.3	45.6	19.9	84.1	70.9	9.20
2	76.1	72.6	96.2	51.7	26.4	96.7	96.5	27.0
3	67.5	53.0	91.8	44.8	36.0	79.9	62.4	18.4
4	57.5	30.4	69.5	9.62	20.8	69.1	40.4	20.1
Mean	64.4	--	82.6	--	--	75.8	--	--
±SD	13.8	--	15.0	--	--	17.8	--	--
r	0.19	--	0.11	--	--	0.30	--	--
Potassium (K)								
Control	289.0	--	409.2	--	41.6	272.8	--	--
1	429.3	48.5	633.5	54.8	47.6	519.1	90.3	20.9
2	423.1	46.4	592.0	44.7	39.9	533.4	95.5	26.0
3	459.0	58.8	594.0	45.2	29.4	489.6	79.5	6.60
4	410.0	41.8	502.8	22.9	22.6	423.9	55.4	3.40
Mean	402.1	--	536.3	--	--	447.7	--	--
±SD	65.7	--	90.3	--	--	106.4	--	--
r	0.65	--	0.25	--	--	0.39	--	--
Calcium (Ca)								
Control	21.1	--	36.2	--	71.5	23.5	--	11.4
1	33.8	60.2	95.9	164.9	183.7	69.8	197.0	106.5
2	69.7	230.3	75.9	109.6	8.9	71.6	204.6	2.7
3	77.0	264.9	59.4	64.0	-22.8	64.6	174.9	-16.1
4	72.5	243.6	36.2	00.0	-53.2	63.1	168.5	-12.9
Mean ±SD	54.8	--	60.7	--	--	85.5	--	--
	25.5	--	25.8	--	--	19.9	--	--
r	0.90	--	-0.25	--	--	0.58	--	--
Magnesium (Mg)								
Control	31.7	--	49.5	--	56.2	38.5	--	21.5
1	47.2	48.9	72.4	46.2	53.3	55.5	44.2	17.6
2	45.2	42.6	72.2	45.8	59.7	50.7	31.7	12.2
3	45.9	44.8	57.6	16.4	25.2	45.9	19.2	00.0
4	42.5	34.0	39.6	-20.0	-6.8	39.2	1.8	-7.8
Mean	42.5	--	58.3	--	--	46.0	--	--
±SD	6.3	--	14.3	--	--	7.3	--	--
R	0.50	--	-0.39	--	--	-0.18	--	--

SD = Standard deviation r = Correlation Coefficient

*** O.M effect = $\frac{\text{Uptake (Treatment-Control with Fe } SO_4 \text{ or } ZnSO_4) \times 100}{\text{Uptake with Fe } SO_4 \text{ or } ZnSO_4 \text{ control treatment}}$**

**** $FeSO_4$ or Zn SO_4 effect = $\frac{\text{Uptake } (FeSO_4 \text{ or } ZnSO_4 \text{ - Organic manure alone}) \times 100}{\text{Uptake with organic manure alone}}$**

Table 4: Uptake of micronutrients by wheat plants as affected by increased ratio of organic manure with and without $FeSO_4$ or $ZnSO_4$

Treatment	O.M Effect		O.M + $FeSO_4$ effect			O.M + $ZnSO_4$ effect		
	Uptake (mg /pot)	Uptake increase (%)	Uptake (mg/ pot)	*O.M effect (uptake increase %)	**$FeSO_4$ effect (uptake increase %)	Uptake (mg/ pot)	*O.M effect (uptake increase %)	**$ZnSO_4$ effect (uptake increase %)
Iron (Fe)								
Control	1.29	--	2.34	--	81.4	1.60	--	24.0
1	1.89	46.5	5.48	143.2	189.8	3.49	118.1	84.6
2	1.42	10.0	5.18	121.3	264.8	3.67	129.3	158.4
3	1.32	2.32	5.31	126.9	302.2	3.31	106.8	150.7
4	0.68	-47.2	3.85	64.5	466.1	3.07	91.8	351.4
Mean	**1.32**	**--**	**4.43**	**--**	**--**	**3.02**	**--**	**--**
±SD	**0.43**	**--**	**1.33**	**--**	**--**	**0.82**	**--**	**--**
r	**-0.65**	**--**	**0.32**	**--**	**--**	**0.51**	**--**	**--**
Manganese (Mn)								
Control	0.27	--	1.31	--	385.2	0.84	--	211.0
1	0.44	62.9	0.51	-61.0	15.9	1.48	76.2	236.3
2	0.46	70.4	0.50	-61.8	8.7	1.68	100.0	265.2
3	0.46	70.4	0.47	-64.0	2.2	1.29	53.6	180.4
4	.40	48.1	0.36	-72.5	-10.0	0.88	4.76	54.5
Mean	**0.406**	**--**	**0.63**	**--**	**--**	**1.23**	**--**	**--**
±SD	**0.079**	**--**	**0.38**	**--**	**--**	**0.36**	**--**	**--**
r	**0.54**	**--**	**-0.79**	**--**	**--**	**-0.05**	**--**	**--**
Zinc (Zn)								
Control	0.58	--	0.83	--	43.1	0.94	--	62.0
1	1.05	81.0	1.39	67.5	32.4	1.57	67.0	49.5
2	1.00	72.4	1.38	66.2	38.0	1.64	74.5	64.0
3	1.12	93.1	1.58	90.3	41.0	1.68	78.7	46.4
4	1.03	77.6	1.16	39.8	12.6	1.38	46.8	34.0
Mean	**0.96**	**--**	**1.26**	**--**	**--**	**1.44**	**--**	**--**
±SD	**0.21**	**--**	**0.28**	**--**	**--**	**0.30**	**--**	**--**
r	**0.70**	**--**	**0.40**	**--**	**--**	**0.50**	**--**	**--**
Copper (Cu)								
Control	0.07	--	0.10	--	42.8	0.07	--	00.0
1	0.12	71.4	0.11	10.0	-8.3	0.07	00.0	-36.3
2	0.11	57.1	0.12	20.0	8.3	0.10	42.8	-9.0
3	0.13	85.7	0.11	10.0	-15.3	0.15	114.2	15.4
4	0.11	57.1	0.11	10.0	00.0	0.16	128.6	45.4
Mean	**0.108**	**--**	**0.11**	**--**	**--**	**0.11**	**--**	**--**
±SD	**0.02**	**--**	**0.007**	**--**	**--**	**0.04**	**--**	**--**
r	**0.61**	**--**	**0.44**	**--**	**--**	**0.96**	**--**	**--**

SD = Standard deviation r = Correlation Coefficient

*** O.M effect = $\frac{\text{Uptake (Treatment-Control with Fe } SO_4 \text{ or } ZnSO_4) \times 100}{\text{Uptake with Fe } SO_4 \text{ or } ZnSO_4 \text{ control treatment}}$**

**** $FeSO_4$ or Zn SO_4 effect = $\frac{\text{(Uptake (}FeSO_4 \text{ or } ZnSO_4 \text{ - Organic manure alone) x 100}}{\text{uptake with organic manure alone}}$**

CONCLUSIONS

From the present work, it can be concluded that the presence of Farm Yard Manure (FYM) in the root rhizosphere generally leads to availability increase of macro- and micronutrients to be taken up by wheat plant roots. Enrichment of organic manure with iron sulphate or zinc sulphate additionally increased the nutrients taken up by the plants. However, high ratios of the manure in the root area, especially in case of the addition of $FeSO_4$ or $ZnSO_4$, led to negative effects on nutrients uptake and consequently their concentrations in the plant tissues which led, in turn, to less biomass formation.

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تأثير التسميد بمستويات مختلفة من السماد العضوى بدون أو مع اضافة كبريتات الحديدوز أو كبريتات الزنك على صلاحية العناصر للامتصاص لنباتات القمح

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قسم النبات-المركز القومى للبحوث-الدقى-القاهره-ج.م.ع

أجريت تجربة أصص بصوبة برنامج العناصر المغذية الصغرى بالمركز القومى للبحوث على نبات القمح لدراسة أثر تسميده بمستويات مختلفة من السماد العضوى (FYM) مع أو بدون كبريتات الحديدوز أو كبريتات الزنك على تركيزات العناصر المغذية بأنسجة النبات و معدل امتصاصها وكذلك تكوين المادة الجافة. ولقد أوضحت النتائج أن هناك ارتباطا موجبا بين مستويات السماد العضوى وامتصاص العناصر ونسبة المادة الجافة بالنباتات. كما دلت النتائج على أن اضافة كبريتات الحديدوز أو كبريتات الزنك قد أدى الى زيادة اضافية فى كمية العناصر الممتصة بواسطة النباتات وكذلك تركيزاتها داخل الأنسجة مما أدى الى زيادة تكوين المادة الجافة. ولقد كان

لاضافة كبريتات الحديدوز الأثر الأكبر فى هذا الصدد، كما كانت المعاملتان رقم ١ {٢٥,. % من محتوى التربة سماد عضوى (معدل ٥ م٣/فدان) + ٠,٣٥ جم/أصيص كبريتات حديدوز أو كبريتات زنك (بمعدل ٥٠ كج/فدان)} ورقم ٢ {٥,. % سماد عضوى (معدل ١٠ م٣/فدان) + ٠,٣٥ حم/أصيص كبريتات حديدوزأو كبريتات زنك (بمعدل ٥٠ كج/فدان)} أفضل المعاملات. الا أنه وجد أن هناك ارتباطا سالبا بين زيادة مستويات السماد العضوى و بين كمية المادة الجافة بالنبات من جهة وامتصاص عناصر النيتروجين والكالسيوم والمغنيسيوم والمنجنيز من جهة أخرى وذلك فى حالة اضافة كبريتات الحديدوز، بينما وجد فقط ارتباطا سالبا بين زيادة مستويات السماد العضوى وامتصاص كل من المغنيسيوم والمنجنيز فى حالة اضافة كبريتات الزنك.