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Behaviour of Some Micronutrients in Soil and Tomato Plant Organs under Different Levels and Types of Fertilizers

[1]Malak A.E. Ramadan, [2]A.M. El-Bassiony and [2]Hoda A.M.

[1]Soil and Water Use Dept., National Research Centre, Cairo, Egypt.
[2]Vegetables Researches Dept., National Research Centre, Cairo, Egypt.

Abstract: Two field experiments were carried out during two successive seasons of 2005 and 2006 at Banha, Qalubia Governorate, Egypt. The effect of poultry manure and mineral fertilizers on vegetative growth, fruit yield and quality, copper, zinc and manganese contents in soil and tomato plant organs have been investigated. Total fruit yield of tomato crop was increased by increasing fertilizer levels. The available micronutrients (Cu, Zn and Mn) in soil were decreased by growing tomato crop in the two seasons. The available micronutrients in soil increased by using poultry manure comparative by using mineral fertilizers in two levels (100% and 75%) while they were equal by using 50% mineral fertilizers and 50% poultry manure. The vegetative growth was increased by increasing fertilizer levels in the two seasons except in stems at the first season. The highest content of copper in tomato plant organs and its total uptake were obtained by mineral fertilizers. Zinc content of tomato organs was increased significantly in the two seasons except in leaves by the different fertilization levels. The effect of fertilizer type on zinc content of tomato organs was significant in the two seasons except in leaves and stems at the first season and the second season respectively. The effect of fertilizer levels on manganese content was significant at the two seasons except in fruits. At the first season, the effect of fertilizers type on manganese contents was significant except in roots while the results were not significant with its total uptake and stems content at the second season.

Key words: Micronutrients, Soil, Tomato Plants, Mineral Fertilizers, Poultry Manure, Fruit yield and Quality

INTRODUCTION

Tomato is considered the most vegetable crop in Egypt. The area cultivated of tomato crop yearly amounts of 460.000 feddan. The yearly production of tomato crop amounts to seven millions tons consumed fresh or manufactured. So that it is of great importance to try to increase fruit yield and quality. Many attempts are going on to develop better agricultural practices in fertilization, irrigation, sowing dates and other agricultural practices.

Generally, poultry manure is considered to have fertilizing properties intermediate between mineral fertilizers and farmyard manure (Giardini *et al.* 1992), having an appreciable residual effect (Cook 1972). However, more studies are needed to identify the optimum application rate and measure effects on crop growth, yield and quality (Pimpini *et al.* 1992). They added that, soil fertility and environment must also be given to the feasibility of completely or partly substituting poultry manure for mineral fertilizers. This work aims to evaluate the effect of the different ratios of poultry manure and mineral fertilizers on the micronutrient in soil, plant organs, growth, fruit yield and quality of tomato crop.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 2005 and 2006 at Banha, Qalubia Governorate, Egypt to investigate the effect of different ratios of poultry manure and mineral fertilizers on growth, yield, quality and micronutrient contents in soil and tomato plant organs (*Lycopersicon Esculentum* Mill) c.v GS12.

Seeds of GS12 were sown in foam tray field with growing media of 1 peat: 1 vermiculite and transplanted into field on 15th April in the two seasons. Six treatments were compared between three ratios (100%, 75% and 50%) of poultry manure and mineral fertilizer.

Corresponding Author: Malak A.E. Ramadan, Soil and Water Use Dept., National Research Centre, Cairo, Egypt.

The design of the experiments was split – plot with four replicates, where the mineral fertilizer and poultry manure ratios were distributed in the sub – plots. The plot area was 11.2 m^2 included 4 ridges, each with 70 cm. width and 4.0 m. long. Poultry manure was analyzed for micronutrient (Cu, Zn and Mn) as shown in table (1). Before planting, soil samples (0-60 cm) were collected for analyzing available elements as shown in Table (2). Ammonium acetate EDTA mixture (PH 4.65) was used to extract the available elements form (Cottenie *et al*., 1982).

Table 1: Micronutrients in poultry manure and mineral fertilizer

Fertilizer	Total (µg/g)		
	Zn	Cu	Mn
Poultry manure	284.2	1.5	343
Super Phosphate	266	70	372
Ammonium nitrate	0.7	3.8	1.1
Potassium Sulphate	1.3	3.8	3.2

Table 2: The characteristics of soil

Treatment	EC (ds/m)	pH 1-2.5	CaCo3 %	OM %	ESP %	CEC meq/100g	Texture	Available (µg/g)		
								Zn	Cu	Mn
Soil before planting	2.5	8.4	1.4	1.9	13.5	41.5	Clay loam	125.4	2.7	30.4

Aqua Regia was used to digest soil samples for total contents of the investigated micronutrient (Cottenie *et al*., 1982).

The normal agricultural treatments of growing tomato were practiced as usually followed in the commercial production of tomato. Samples of four plants were taken at 80 days after sowing and the plant length, number of leaves and shoots per plant, fresh and dry weight of leaves, stems and roots were recorded.

Tomato fruits were harvested every week. At harvest time the fruit length (cm), fruit diameter (cm), average fruit weight (g) and total weight of fruits in each experimental plot were recorded and the total yield as ton/fed. was accounted.

Samples of leaves, stems, roots and fruits were dried at 70ºC, then fine grounded and wet digested according to the methods described by Jackson (1967). The zinc, copper and manganes contents were determined using Atomic Absorption Spectrophotometer, according to Ramadan and Al-Ashker (2001a & b). All the obtained data were subjected to statistical analysis of variance according to the procedure outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

Vegetative Growth:

Effect of Fertilizers Levels:

As shown in table (3) vegetative growth of tomato plants expressed as plant length, shoots and leaves numbers, fresh and dry weight of total plant and its organs (leaves, stems and roots) was gradually increased by increasing fertilizers level. Increasing fertilizer level gradually from 75% to 100% increased gradually and statistically vegetative growth of tomato plants. Whereas, shoots number and dry weight of leaves in the first season and fresh weight of stem in the second season failed to reach the level of significance. These increases were true and statistical in the two seasons of the experiment.

Effect of Fertilizer Type:

Mineral fertilizer and poultry manure had a slow effect on the vegetative growth of tomato plants. Number of shoots, number of leaves and plant length as well as leaves, stems and total plant fresh weight were increased by poultry manure compared with mineral fertilizer. Increases in the total plant fresh weight due to poultry manure application were statistically significant in the two seasons of the experiment.

Togun and Akanbi (2003) found that plant material fortified with poultry manure significantly increased dry matter of tomato plants compared with mineral fertilizers.

Increases in the fresh weight of tomato plants by applying poultry manure might be referred to its role in enhancing soil physical prosperities and water holding capacity. Heeb *et al*., (2005) reported that the mean tomato plant shoot biomass was significantly higher for the plants grown with mineral solution compared with chicken. They added that there was no significant difference in the dry matter content of tomato plants.

Table 3: The effect of levels and types of fertilizers and their interactions on vegetative growth of tomato plant during 2005-2006 seasons:

The effect		Plant length (cm)	No. of leaves /plant	No. of shoots /plant	Fresh weight (g)				Dry weight (g)			
					Leaves	Stems	Roots	Total plant	Leaves	Stems	Roots	Total plant
Fertilizers levels												
2005												
100%		54.5	45.5	7.33	48.2	36.86	9.86	94.92	11.83	7.33	3.43	22.59
75%		50.83	38.17	7.33	49.02	35.03	7.17	91.22	11.15	5.73	2.04	18.92
50%		42.42	27	6.17	36.59	28.95	5.94	71.47	10.46	4.54	1.83	16.84
LSD at 5%		8.35	8.03	NS	7.11	2.88	1.12	2.13	NS	0.77	0.66	2.88
2006												
100%		51.5	44.17	7.5	39.99	29.48	6.3	75.76	10.95	4.89	2.52	18.37
75%		41.67	36.83	6	34.03	26.97	5.74	66.73	8.37	4.21	2.26	14.84
50%		36.42	34	5.33	30.22	24.79	4.69	59.7	6.01	3.15	1.7	10.85
LSD at 5%		5.64	6.14	1.58	6.99	NS	1.32	3.54	3.27	1.14	0.54	3.12
Fertilizer type												
2005												
Mineral		48	36.33	6.89	44.03	31.38	7.65	83.06	12.2	6.58	2.57	21.35
Poultry		50.5	37.44	7	45.18	35.84	7.67	88.68	10.09	5.15	2.3	17.54
LSD at 5%		NS	NS	NS	NS	3.25	NS	4.15	NS	1	NS	3.09
2006												
Mineral		42.56	39.78	6.11	32.54	25.2	6.01	63.75	9.15	4.27	2.13	15.55
Poultry		43.83	36.89	6.44	36.95	28.95	5.14	71.04	7.73	3.9	2.19	13.82
LSD at 5%		NS	NS	NS	NS	NS	0.53	5.67	NS	0.21	NS	NS
Interaction												
2005												
100%	Mineral	55	47	7.67	49.32	31.26	9.68	90.26	12.63	8.64	3.64	24.91
	Poultry	54	44	7	47.08	42.45	10.04	99.57	11.02	6.02	3.22	20.26
75%	Mineral	50.67	33.67	7	49.66	31.64	6.99	88.29	12.87	6.62	2.33	21.82
	Poultry	51	42.67	7.67	48.38	38.42	7.35	94.15	9.43	4.84	1.74	16.01
50%	Mineral	38.33	28.33	6	33.1	31.25	6.27	70.62	11.1	4.49	1.73	17.32
	Poultry	46.5	25.67	6.33	40.07	26.64	5.61	72.32	9.82	4.6	1.93	16.35
LSD at 5%		NS	NS	NS	NS	5.62	NS	NS	NS	NS	NS	NS
2006												
100%	Mineral	52	51	7.33	37.03	27.77	7.18	71.98	11.41	4.8	2.71	18.92
	Poultry	51	37.33	7.67	42.94	31.19	5.41	79.54	10.49	4.98	2.34	17.81
75%	Mineral	42	36	5.67	32.57	24.79	6.17	63.53	9.21	4.33	2.26	15.8
	Poultry	41.33	37.67	6.33	35.48	29.14	5.3	69.92	7.53	4.1	2.25	13.88
50%	Mineral	33.67	32.33	5.33	28.02	23.05	4.67	55.74	6.84	3.67	1.42	11.93
	Poultry	39.17	35.67	5.33	32.42	26.53	4.71	63.66	5.17	2.62	1.98	9.77
LSD at 5%		NS	7.44	NS	NS	NS	0.92	NS	NS	NS	NS	NS

Oikeh and Asiegbu (1993) found that high manure application of 30 t/ha. depressed growth of tomato plants due to slow release of nutrients that were still bound in the organic forms in the manures. The ultimate advantages associated with the organic manures compared with NP fertilizer were, in part, ascribed to their probable effects on the soil physical characteristics and their supply of macro and micronutrient elements not contained in NPK fertilizer. These results agree with those obtained by Raut *et al.* 2006; Hu and Barker 2004 and Ami and Sabie 2004.

Effect of the Interaction:

Vegetative growth of tomato plants expressed as number of shoots and leaves, plant length as well as fresh and dry weight of the total plant and its organs, i.e. leaves, stems and roots were not statistically affected by the interaction of fertilizers. These results indicated that the two factors act independent on the vegetative growth of tomato plants.

Fruit Yield and Quality:

Effected of Fertilizers Levels:

Total fruit yield of tomato crop was increased by increasing fertilizers levels. This increase was statistically significant in the two seasons of the experiment.

There was linear relationship between the total yield and fertilizers levels up to its highest level, i. e. 100%mineral fertilizers or 100%poultry manure.

The increase in the total fruit yield was the summation of increases in the vegetative growth and nutrients uptake followed by increases in the net assimilation rate and increases in the biosynthesis's accumulation resulting by fertilizers increases. Giardini *et al.* (1992) came to similar results. They reported that the highest yields of tomato were obtained by the highest rate of nutrients.

Table 4: Effect of levels and types of fertilizers and their interaction on fruit yield and quality of tomato crop during 2005-2006 seasons.

The effect		2005					2006				
		Total yield ton/fed.	Fruit length(cm)	Fruit diameter(cm)	Fruit weight(g)	T.S.S.	Total yield ton/fed.	Fruit length(cm)	Fruit diameter(cm)	Fruit weight(g)	T.S.S.
Fertilizers	levels										
100%		20.57	4.37	4.8	60.92	4.75	20.44	5.45	4.47	61.52	5.13
75%		18.7	24.17	4.67	51.22	4.35	18.43	4.87	4.3	47.48	4.53
50%		16.25	3.80	3.75	39.62	3.93	15.61	4.30	3.95	38.68	3.67
LSD at 5%		1.23	NS	0.66	9.46	NS	1.65	0.6	0.2	7.19	0.38
Fertilizer	type										
Mineral		18.13	4.10	4.42	55.03	4.43	18.00	4.78	4.46	51.04	4.78
Poultry		18.69	4.12	4.39	46.13	4.26	18.32	4.97	4.02	47.41	4.11
LSD at 5%		0.33	NS	NS	5.26	NS	0.18	NS	NS	NS	0.45
Interaction											
100%	Mineral	19.87	4.13	4.6	63.97	4.67	20.33	5.77	4.48	61.1	5.77
	Poultry	20.66	4.60	5.00	57.87	4.83	20.54	5.13	4.47	61.94	4.5
75%	Mineral	18.46	3.83	4.57	56.5	4.27	18.12	4.40	4.60	55.37	4.4
	Poultry	18.97	4.50	4.77	45.93	4.43	18.74	5.33	4	39.6	4.67
50%	Mineral	16.06	4.33	4.1	44.63	4.37	15.55	4.17	4.3	36.67	4.17
	Poultry	16.43	3.27	3.4	34.6	3.5	15.67	4.43	3.6	40.68	3.17
LSD at 5%		2.46	0.97	NS	NS	NS	2.26	NS	NS	NS	0.78

The quality of tomato fruits was enhanced byfertilizers increases up to its highest level. Fruit length, diameter and weight as well as T.S.S content were increased by increasing fertilizers levels up to its highest ratios, i. e. 100%,similar results were obtained in the two seasons of the experiment,Table(2).

Effect of Fertilizer Type:

From table (4), it is clear that increases in tomato fruit yield were noticed by poultry manure compared with mineral fertilizer. These increases were significant and similar in the two seasons of experiment. Application of poultry manure resulted in increases in fruit yield amounted to 0.56 and 0.32 ton/feddan in the first and second seasons, respectively. The increase in the total fruit yield by poultry manure might be due to its favorable effect on the physical prosperities of the soil, aeration and water holding capacity which reflected better growth and higher net assimilation rate. Increases in the total fruit relied nutrients in the soil supplied by poultry manure.

Togun and Akanbi (2003) found that the highest tomato yields were obtained by a mixed fertilization (organic +mineral) on the other hand, there were no significant differences in fruit yield due to different forms of fertilizers (Toor *et al*., 2006, and Heeb *et al*., 2005).

Data in table (4) indicated that there were no significant differences in fruit quality between mineral fertilization and poultry manure. Fruit length, diameter, weight and T.S.S. content were not affected by fertilizer type.

Effect of the Interaction:

The highest values of fruit yield were obtained by application of poultry manure with the highest fertilizer level, 100%. On the other hand, the lowest total fruit yield was obtained by the mineral fertilization at 50%. Other interaction treatments lied between these two percentages. These results were true and similar in the two seasons of the experiment.

The quality of tomato fruits expressed as fruit length, diameter, weight and T.S.S was not statistically affected by the interaction of fertilizers levels and type.

The Available Micronutrients in Soil under Different Treatments in Two Seasons:

Tables (5-7) show that the available micronutrients (Cu, Zn and Mn) in soil were decreased by planting in the two seasons. By using poultry manure the available micronutrients in soil increased comparative by using mineral fertilizers in two levels (100% and 75%) while they were equality by using 50% mineral fertilizers and 50% poultry manure.

In all treatments, the available copper is more than the adequate (0.2 µg/g) according to Follet and Lindsay (1970). In the first season, the available Cu are more than the value of non polluted soils of Egypt (1.86 to 2.5 µg/g), Aboulroos et al, 1996, while the all values of copper are in range (0.002 to 180 µg/g) of normal soil (Liphadzi et al, 2002). The available Zn lies in the range of nonpolluted soils (0.01 to 200 µg/g) and in the range of critical levels (70 to 400 µg/g) according to Kirkham, 1979 and Kabata Pendias and Pendias, 1984 respectively. Also they are in range (1.5 to 264 µg/g) of international standers (Sauza *et al,* 1996) and more than the value (1.56 to 2.64 µg/g) DTPA extractable of nonpolluted soils in Egypt, according to Aboulroos *et al,* 1996.

Table 5: Effect of levels and types of fertilizers and their interaction on Cu in soil and tomato organs during 2005-2006 seasons.

Treatments		2005						2006					
		Soil at harvest (µg/g)	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)	Total uptake mg/plant	Soil at harvest (µg/g)	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)	Total uptake mg/plant
Fertilizers levels													
100%		2.79	33.50	20.50	21.75	24.00	2.22	2.66	33.50	29.00	19.00	28.00	2.00
75%		2.57	31.00	21.00	17.50	39.00	2.09	2.33	38.25	20.50	29.50	36.50	1.85
50%		2.67	42.50	19.50	30.50	50.75	2.41	2.45	48.75	27.50	28.25	41.25	1.59
LSD at 5%			3.97	NS	3.50	7.45	0.11		4.10	1.37	NS	3.56	0.19
Fertilizer type													
Mineral		2.61	28.67	25.67	20.83	44.17	2.47	2.44	37.33	28.50	22.17	37.33	1.89
Poultry		2.74	42.67	15.00	25.67	31.67	2.02	2.52	33.17	22.83	29.00	33.17	1.74
LSD at 5%			10.05	5.16	NS	4.33	0.20		NS	3.26	5.32	NS	NS
Interaction													
100%	Mineral	2.71	23.50	24.00	15.50	24.50	2.18	2.66	34.50	29.50	15.00	17.50	1.83
	Poultry	2.86	43.50	17.00	28.00	23.50	2.27	2.66	32.50	28.50	23.00	38.50	2.18
75%	Mineral	2.44	25.50	30.50	15.50	50.50	2.66	2.22	32.50	26.50	22.50	46.00	2.01
	Poultry	2.70	36.50	11.50	19.50	27.50	1.52	2.44	44.00	14.50	36.50	27.00	1.69
50%	Mineral	2.67	37.00	22.50	31.50	57.50	2.57	2.45	46.00	29.50	29.00	48.50	1.83
	Poultry	2.67	48.00	16.50	29.50	44.00	2.26	2.45	51.50	25.50	27.50	34.00	1.35
LSD at 5%			NS	NS	NS	NS	NS		NS	NS	NS	NS	NS

The available copper and zinc are in range 1-20 µg/g and 3-50 µg/g respectively of common concentration, while they are lower than the maximum tolerable concentrations (100 µg/g Cu and 300 µg/g Zn) according to Ewers (1991). According to Follet and Lindsay (1970), the available Mn is more than the reported value (>1.0 µg/g), while it is less than the maximum tolerable concentration (300 µg/g) and the normal range (15 to 1250 µg/g) reported by Ewers, (1991) and Liphadzi *et al,* (2002) respectively.

Micronutrients Content of Tomato Organs:

Copper Contents of Tomato Plant Organs and its Total Uptake:

Table (5) shows the effect of levels and fertilizers type on Cu in soil and tomato organs during 2005-2006 seasons. The interaction of fertilizer type and levels are also found.

The Effect of Fertilizers Levels:

At the first season, the highest copper content in tomato plant organs was recorded by 50% mineral fertilizers or poultry manure except in the stems. At the second season, the highest content of copper in tomato plant organs and its total uptake were different with the different fertilizer levels. The effect of fertilizers levels was significant in the two seasons except in stems and fruits at the first and second season, respectively (Table 5).

The Effect of Fertilizer Type:

The behaviour of copper contents in tomato plant organs at two seasons was similar except in leaves. The effect of fertilizer type on copper contents was significant except in fruits, at the first season. At the second season the results were not significant except in stems and fruits. The highest contents of copper in tomato plant organs and total uptake were found by using mineral fertilizers.

The Effect of Interaction:

Application of 100% poultry manure resulted in, the highest content and total uptake of copper were found in leaves and fruits at the first season, while the highest copper contents and total uptake were found in fruits and roots at the second season. When 75% and 50% mineral fertilizers or poultry manure were used, the behaviour of copper contents in tomato plant organs and total uptake were similar at the two seasons. Mineral fertilizers increased the copper contents in stem, roots and total uptake by using 75% level. Using 50% mineral fertilizers, copper content increased in fruits, stems, roots and total uptake at the two seasons. The effect of interaction between the types and levels of different fertilizers and copper content were not significant at the two seasons.

Comparison of Copper Content with International Levels:

Comparing the data in Table (5) with the reported levels, it can be found that, according to Beeson 1941 and Chapman, 1973, the contents of copper in most organs of tomato plants are in normal concentrations ranges (4 to 40µg/g). Also they are in ranges of phytotoxic level (25-40, 10-70 and 20- 100 µg/g) reported by Chaney, 1989, Gupta and Gupta 1998 and Kabata- Pendias and Pendias, 2000 respectively. The copper contents in most organs of tomato plant are more than the maximum level tolerated by sheep (25 µg/g) mentioned by Chaney, 1989.

Zinc Content of Tomato Plant Organs and its Total Uptake:

Table (6) shows the effect of levels and fertilizers type on Zn in soil and tomato organs during 2005-2006 seasons. The interaction of fertilizer type and levels are also found.

Table 6: Effect of levels and types of fertilizers and their interaction on Zn in soil and tomato organs during 2005-2006 seasons

		2005						2006					
Treatments		Soil at harvest (µg/g)	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)	Total uptake mg/plant	Soil at harvest (µg/g)	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)	Total uptake mg/plant
Fertilizers levels													
100%		4.01	107.53	185.23	103.03	276.6	15.32	2.84	104.35	112.05	114.55	143.9	8.73
75%		3.93	108.23	147.74	126.1	273.8	12.34	3.71	108.38	143.13	89.85	252.58	8.87
50%		4.43	108.78	131.95	94.8	197.88	9.03	4.48	102.33	111.13	89.08	195.38	5.44
LSD at 5%			NS	11.18	5.65	NS	2.25		NS	3.5	8.75	21.4	1.77
Fertilizer type													
	Mineral	3.3	113.37	166.39	104.42	283.53	14.37	3.26	113.97	122.77	102.45	218.72	8.63
	Poultry	4.95	102.98	143.55	111.53	215.32	10.1	4.09	96.07	121.43	93.2	175.85	6.73
LSD at 5%			NS	12.88	6.31	20.26	2.68	8.58		NS	7.05	25.13	1.34
Interaction													
100%	Mineral	2.29	100.25	210.25	105.35	315.65	18.22	2.1	118.3	117.8	122.9	128.55	9.22
	Poultry	5.73	114.8	160.2	100.7	237.55	12.42	3.57	90.4	106.3	106.2	159.25	8.23
75%	Mineral	3.18	112.05	158.43	107.75	255.85	13.84	2.9	123.05	125	89	312.05	10.26
	Poultry	4.68	104.4	137.05	144.45	291.75	10.85	4.51	93.7	161.25	90.7	193.1	7.48
50%	Mineral	4.43	127.8	130.5	100.15	279.1	11.04	4.78	100.55	125.5	95.45	215.55	6.41
	Poultry	4.43	89.75	133.4	89.45	116.65	7.02	4.18	104.1	96.75	82.7	175.2	4.48
LSD at 5%			NS	11.35	NS	NS	NS		NS	9.89	6.1	NS	NS

The Effect of Fertilizers Levels:

At the first season, the highest content of zinc was found in stems, roots and total uptake by using 100% of the different fertilizers. The high content of zinc was found by using 75% of the different fertilizers, in all organs and total uptake. The effect of fertilizers levels on zinc contents of tomato organs was significant in two seasons except in leaves.

The Effect of Fertilizer Type:

The high contents of zinc were found in all organs and the total uptake by using mineral fertilizers at two seasons except in the fruits. The effect of fertilizers type on zinc contents of tomato organs was significant in two seasons except in leaves and stems at the first season and the second season respectively.

The Effect of Interaction:

In case of using 100% mineral fertilizers, the content of zinc was increased in all organs of tomato plant and its total uptake at the two seasons except its contents in leaves and roots at the first and the second seasons respectively. At the two seasons, the highest zinc content was recorded in leaves and total uptake. The high zinc content was found in all organs of tomato plants and total uptake by using 50% mineral fertilizers at the two seasons except in stems and leaves at first and second season respectively. The effect of interaction on zinc content was not significant except the result in stems, at the first season, while it was significant in stems and fruits at the second season.

Comparison of Zinc Contents with International Levels:

The zinc content in all organs of tomato plants under different treatments are more than the normal concentration range (10 to 100 µg/g), mentioned by Beeson, 1941 and Chapman, 1973 except in leaves and fruits by using 50% poultry manure, at the first season. At the second season, the zinc contents in most organs of tomato plants are more than the normal concentrations range. At two seasons, the zinc contents in all organs of tomato plants are in range of toxic levels (100 – 400 µg/g) according to Kabata – Pendias and Pendias, 2000.

Manganese Contents of Tomato Plant Organs and its Total Uptake:

Table (7) shows the effect of levels and fertilizers type on Mn in soil and tomato organs during 2005-2006 seasons. The interaction of fertilizer type and levels are also found.

The Effect of Fertilizers Levels:

The highest total uptake of manganese was recorded by 100% mineral fertilizers or 100% poultry manure at two seasons. In case of using 75% mineral fertilizers or 75% poultry manure, the high manganese content was found in fruits, leaves and stems, at the two seasons. The effect of fertilizers on manganese content was significant at two seasons except in fruits.

Table 7: Effect of levels and types of fertilizers and their interaction on Mn in soil and tomato organs during 2005-2006 seasons

Treatments		2005						2006					
		Soil at harvest (µg/g)	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)	Total uptake mg/plant	Soil at harvest (µg/g)	Total uptake mg/plant	Leaves (µg/g)	Stems (µg/g)	Fruits (µg/g)	Roots (µg/g)
Fertilizers levels													
100%		5.27	141.5	88.5	58.5	290	13	5.32	123.5	87	53.25	351.25	11.27
75%		5.13	141.5	104.75	69.25	290.25	11.34	4.97	157	103.5	55	271.5	8.7
50%		5.3	135.25	85.45	55.5	168.25	7.48	4.76	145.5	91.5	54	196.5	5.23
LSD at 5%			3.22	2.14	NS	23.15	2.06		9.12	3.42	NS	35.46	1.71
Fertilizer type													
	Mineral	5.09	122.5	105.5	50.67	242	11.26	4.97	133.67	97.5	44	255.33	8.43
	Poultry	5.37	156.33	80.3	71.5	257	9.96	5.06	150.33	90.5	64.17	290.83	8.38
LSD at 5%			3.87	6.31	11.35	NS		1.03	7.32	NS	12.01	15.14	NS
Interaction													
100%	Mineral	5.05	147.5	110.5	67.5	225.5	13.73	5.12	152	101	47	279	10.95
	Poultry	5.48	135.5	66.5	49.5	354.5	12.28	5.51	95	73	59.5	423.5	11.59
75%	Mineral	4.91	113	110.5	54	287.5	12.33	5.04	148.5	96	57.5	277.5	9.16
	Poultry	5.34	170	99	84.5	293	10.35	4.9	165.5	111	52.5	265.5	8.25
50%	Mineral	5.3	107	95.5	30.5	213	7.72	4.76	100.5	95.5	27.5	209.5	5.17
	Poultry	5.3	163.5	75.4	80.5	123.5	7.24	4.76	190.5	87.5	80.5	183.5	5.3
LSD at 5%			5.16	9.36	NS	NS		NS	30.15	NS	NS	NS	NS

The Effect of Fertilizer Type:

Poultry manure increased the manganese content in fruits, leaves and roots at the two seasons while the highest total uptake was recorded by mineral fertilizers. At the first season, the effect of fertilizers type on manganese contents was significant except in roots while the results were not significant with total uptake and stems at the second season.

The Effect of Interaction Between the Rates of Different Fertilizers and Manganese Contents:

At the first season, mineral fertilizers increased total uptake in all treatments while poultry manure increased the total uptake at 100% and 50% levels. In the two seasons, 100% mineral fertilizers increased the manganese content in leaves and stems while 100% poultry manure increased the manganese content in roots. When 75% poultry manure was applied, manganese content in fruits, leaves and roots, was increased at the first season. Also it increased the manganese content in leaves and stems at the second season. At two seasons, 50% poultry manure increased the manganese content in fruits and leaves, while 50% mineral fertilizers increased the manganese contents in stems and roots. The effect of interaction between the ratios of different fertilizers and the manganese content was not significant except in leaves and stems at first season and in leaves at the second season.

Comparison of Manganese Contents with International Levels:

According to Beeson, 1941 and Chapman, 1973, the contents of manganese in all organs are in normal ranges (25 – 300 µg/g) except in roots in case of using 100% poultry manure at two seasons.

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