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The Effect of Chicken Manure and Mineral Fertilizers on Distribution of Heavy Metals in Soil and Tomato Organs

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Abstract: Field experiment was carried out at Banha (Qalubia Governorate) to investigate the effect of the chicken manure and mineral fertilizer on distribution of heavy metals in the different organs of two varieties of Tomato (GS 12 and Alisa), and their fruit yields. Treatments were 100% mineral fertilizers, 75% mineral fertilizers plus 25% chicken manure, 50% mineral fertilizers plus 50% chicken manure, 25% mineral fertilizers plus 75% chicken manure and 100% chicken manure. The available Zn was decreasing in soil with cultivation, while the available Pb was increasing with cultivation except by using 25% chicken manure plus 75% mineral fertilizer. Alisa variety realeased the available Zn, while GS variety was realeased the available Pb, Zinc contents in the two varieties of Tomato and their organs are more than the normal range. Also they are in range of toxic levels. Lead contents in all organs of two varieties under different treatments are more than the maximum amounts, normal levels and toxicity level for livestock. Also they are more than accepted as safe for human consumption. The high total yield was recorded with GS12 variety in all treatment, but the best treatments were 25% chicken manure plus 75%mineral fertilizer then 75%chicken manure plus 25%mineral fertilizer.

Key words: Soils, Tomato *(Lycopersicon esculentum Mill.),* Mineral fertilizers, Chicken manure, Heavy metals, Yield.

INTRODUCTION

Tomato crop is the most important vegetable crop grown in Egypt. The increasing demands of the expanding population for food and energy necessitate increasing total yield per feddan (El-Asdoudi *et al*. 1990).

Soil contamination with heavy metals and toxic elements due to parent materials or point sources often occurs in a limited area and is easy to identify-Repeated use of metal – enriched chemicals, fertilizers, and organic amendments such as sewage sludge as well as wastewater may cause contamination at a large scale. Zhenli *et al*, (2005), Chaney (1993), indicated that after "natural" phytotoxicity from aluminum or Mn in strongly acid soils, Zn phytotoxicity is the next most extensive micronutrient phytotoxicity compared to Cu, Ni, Co, Cd or other trace element toxicities, with decreasing soil pH, Zn solubility and uptake and potential for Zn phytotoxicity increases. At comparable soil pH and total Zn concentrations, Zn phytotoxicity is more severe in plants grown in light-textured than in heavy – textured soils. This is mainly because of differences in specific Zn adsorption capacities of the soil. Continued applications of Zn to alkaline sandy soils low in organic matter and clay tend to develop Zn toxicity in plants even through occurrence of Zn toxicity is relatively rare under field conditions (Rattan and Shukla, 1984).

MATERIALS AND METHODS

Tomato seedlings (Lycopersicon esculeintum Mill) were transplanted in the 12 of June. The design of experiments was split – plot with four replicates, where Fertilization treatment were distributed in the main plots. Treatments of mineral fertilizers and chicken manure were 100% mineral fertilizers, 75% mineral fertilizers plus 25% chicken manure, 50% mineral fertilizers plus 50% chicken manure, 25% mineral fertilizers plus 75% chicken manure and 100% chicken manure and two varieties in sub–plots (Gs12 and Alisa).

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Table 1: The characteristics of soil, chicken manure and mineral fertilizer at Pre-Treatment

					Total (µg/g)		Added elements to cultivated area (µg/g)		Available (µg/g)	
Treatment	EC(ds/m)	pH1-2.5	$CaCo_3$ %	Texture	Zn	Pb	Zn	Pb	Zn	Pb
Soil before cultivation	2.5	8.4	1.4	Clay loam	378.0	41.5			125.4	2.4
Chicken manure					284.2	110.5				
Super Phosphate					266.0	30.0	139.4	15.7		
Ammonium nitrate					0.7	20.0	0.9	26.2		
Potassium Sulphate					13	23.0	0.3	6.0		

Doses of the 100% mineral fertilizers and 100% chicken manure are the recommended doses by the Agri. Res. Center in Cairo. The plot areas was 11.2 m2 each included 4 ridges, with 70 cm width and 4 m Long. The physical and chemical properties of the experimental soil, chicken manure and mineral fertilizers are presented in Table (1).

Chicken manure and NPK fertilizer were analyzed for total metals Pb and Zn using mixture of concentrated acids (Cottenie *et al*. 1982). Values are presented in table (1).

Before cultivation, soil samples of all the field treatments (0-60 cm) were collected and analyzed for available and total Pb and Zn. Ammonium acetate- EDTA mixture (pH = 4.65) was used to extract the available elements form, (Cottenie *et al*. 1982). Aqua Regia was used to digest soil samples for total contents of the investigated heavy metals (Cottenie *et al*. 1982). At harvest time, soil samples were collected to represent each soil treatments to measure the available, Zn and Pb. Plant samples from roots, stems, leaves and fruits were collected, oven dried, fine grounded and digested by a mixture of concentrated acids (Cottenie *et al*. 1982). Lead and Zn were measured using Varian SpectrAA 220 Atomic Absorption spectrometry (AAS). Zinc was determined in soil and plant organs applying micro-sampling technique. This could overcome the matrix and nebilization difficulties in high salt sample solution, while lead was determined applying graphite furnace–AAS (Ramadan and AL Ashkar, 2001a; Ramadan and AL-Ashkar, 2001. b). At harvest time, tomato fruits were collected and the total yield as ton / fed in each treatment was accounted. All the obtained data for total yield were subjected to statistical analysis of variance according to the procedure outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSIONS

***1- Heavy Metals in Soil Before Cultivation*:**

Table (1) shows that the total Zn is higher than 50ug/g and 200ug/g while total Pb is lower than 100ug/g and 50ug/g according to Cottenie *et al*. (1982) and Ewers, (1991) respectively. Also the total Pb is lower than the normally found in earth minerals, the average concentration of the metal in uncontaminated soils is less than 50ug Pb/g. (Adriano, 1986). The available Pb and Zn are in range of common concentration (0.10-20 and 3-50ug/g), but they are lower than the maximum tolerable concentration (100ug/g and 300ug/g), respectively mentioned by Ewers, (1991). The available Zn lies in the range of nonpolluted soils (0.01 to 200ug/g) reported by Kirkham, (1979). Also it lies in critical levels (70 to 400ug/g) according to Kabata-Pendias and Pendias (1984), and it is in range (1.5 to 264 ug/g) of international standers (Souza, *et al.* 1996). The available Zn is higher than the value (1.5 to 2.64ug/g DTPA extractable) of nonpolluted soils in Egypt (Aboulroos, *et al.* 1996). The available Pb is lower than the critical level (100 to 400ug/g) reported by Kabata-Pendias and Pendias (1984) and lower than maximum tolerable concentration (100ug/g) according to Ewers (1991). Fig (1). The available Pb is within the range of international criteria (0.5 to 135 ug/g) mentioned by Souza *et al*. (1996). According to Aboulroos *et al*. (1996), the background level of extractable Pb in nonpolluled soils of Egypt ranged from 1.17 to 1.61 ug/g. Fig. (1).

***2- The Available Heavy Metals in Soil at Harvest Time*:**

From Fig (1), it is clear that the available Zn was decreasing in soil with cultivation, while the available Pb was increasing with cultivation except by using 25% chicken manure plus 75% mineral fertilizer, they were decreasing. Alisa variety realeased the available Zn, while Svariety realeased the available Pb. The available Zn in all treatments lies in the range of nonpolluted soils according to Kirkham (1979), and Souza *et al*. (1996). In addition, they are lower than the critical levels mentioned by Kabata-Pendias and Pendias (1984). The available Pb in all treatments are lower than the critical level reported by Kabata –Pendias and Pendias (1984). Also they are in range of common concentration and lower than the maximum tolerable concentration according to Ewers (1991). The available Pb are in range of international criteria reported by Souza *et al*. (1996). According to Aboulros *et al* (1996), the soil is polluted by Pb.

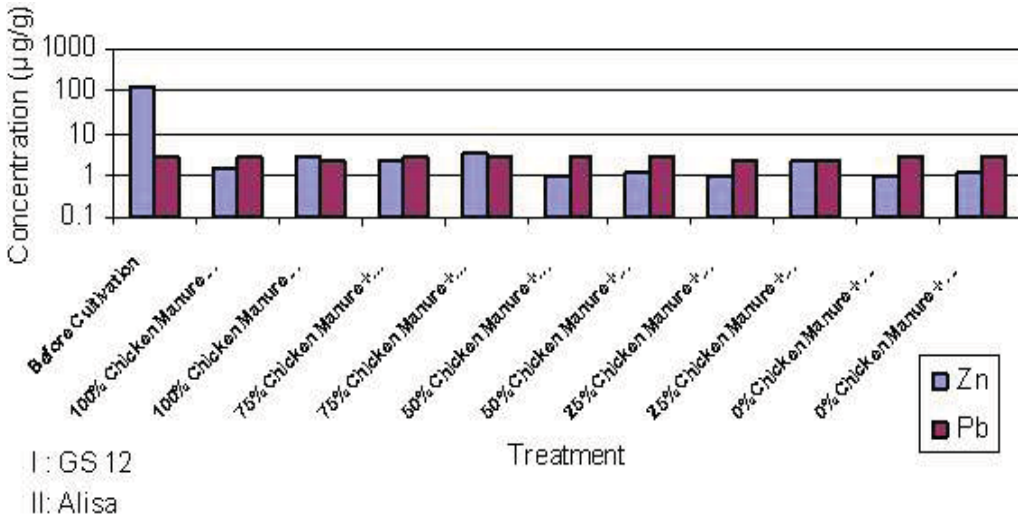

Fig 1: Effect of different rates of fertilizers on Zn and Pb concentration in two tomato cutivars

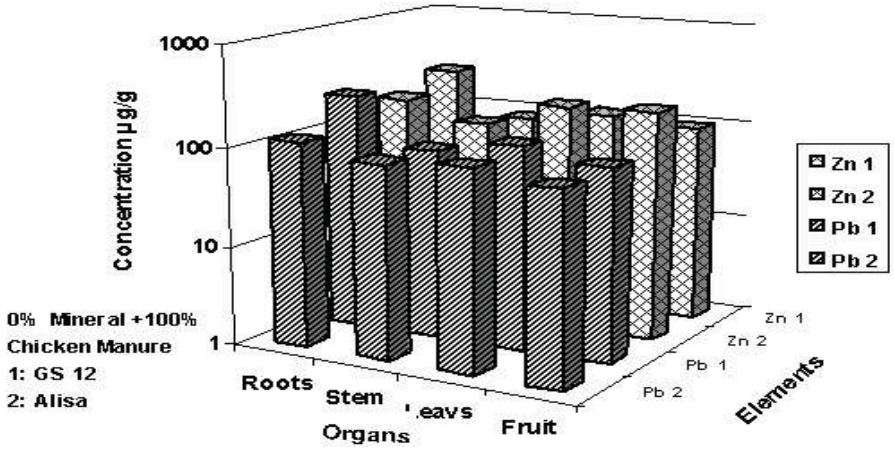

Fig 2: Behaviour of heavy metals in different Tomato organs

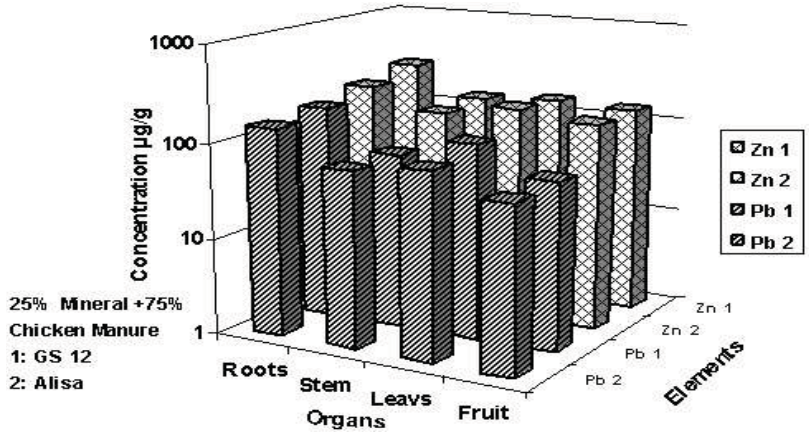

Fig 3: Behviour of heavy metals in different Tomato organs

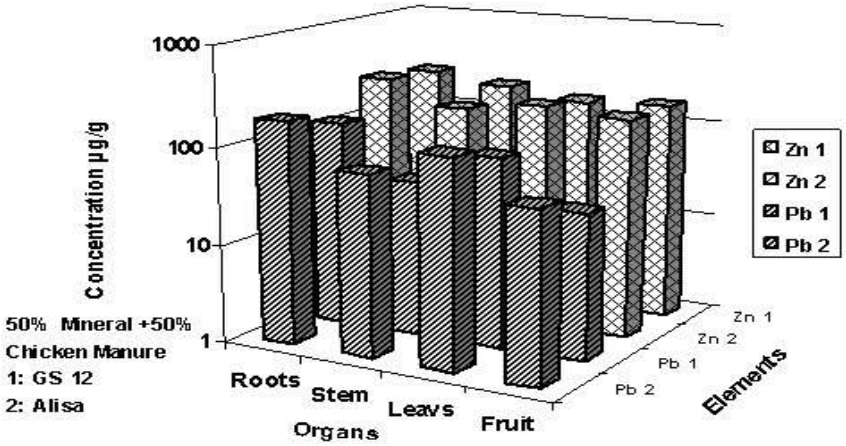

Fig 4: Behviour of heavy metals in different Tomato organs

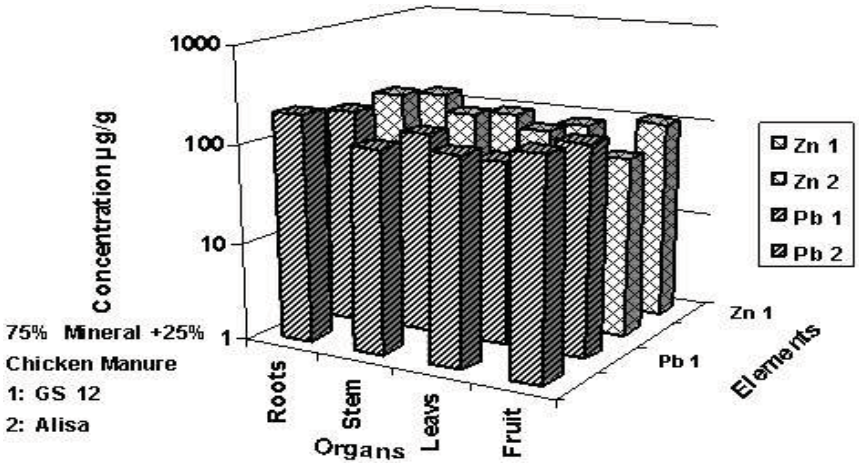

Fig 5: Behviour of heavy metals in different Tomato organs

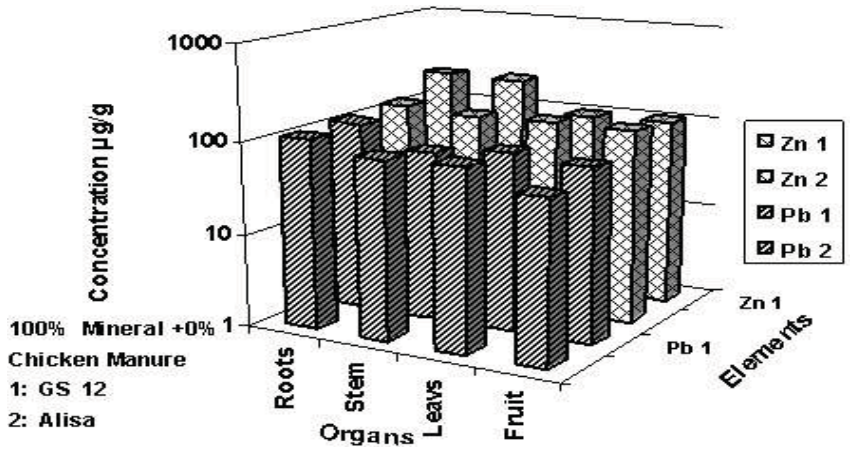

Fig 6: Behviour of heavy metals in different Tomato organs

Table 2: Total Yield (ton/fed)

Treatment	Total Yield (ton / fed) GsS12	Alisa	Mean
100% mineral fertilizer +0% chicken manure	21.40	17.60	19.5
75% mineral fertilizer +25% chicken manure	24.40	19.40	21.9
50% mineral fertilizer +50% chicken manure	23.60	20.40	22.0
25% mineral fertilizer +75% chicken manure	24.10	19.40	21.6
0% mineral fertilizer +100% chicken manure	23.90	18.70	21.3
Mean	23.48	19.10	

LSD Var =2.15 Treat =0.11 Var X Treat =1.33

3- The Comparison Between Heavy Metals Contents in Two Varieties of Tomato under Different Rates from Chicken Manure and Mineral Fertilizers:

3-1- By Using 100% Chicken Manure:

The high contents of Zn were found in Alisa variety than GS variety except in roots. The high contents of Pb were found in Gs organs except in stem compared with Alisa. Fig (2).

***3-2- By Using 75% Poultry Manure plus 25% Mineral Fertilizers*:**

From Fig (3), it is clear that the high contents of Zine were found in roots and stems of GS variety, also they were found in leaves and fruits of Alisa variety the high contents of lead were found in GSorgans except in stems were lower compared with Alisa organs.

3-3- By Using 50% Poultry Manure plus 50% Mineral Fertilizers:

The high contents of Zinc were found in Alisa organs except in stems compared with GS variety. The high contents of lead were found in Alisa organs. Fig (4).

3-4 By Using 25% Poultry Manure plus 75% Mineral Fertilizers:

Fig (5) shows that the high Zn contents were found in Alisa organs except in fruits compared with GS organs. The high lead contents were found in Alisa organs.

3-5- By Using 100% Mineral Fertilizers:

The high Zn contents were found in Alisa leaves and fruits, also they were found in GS roots and stems. The contents of lead were higher in GS fruits and roots compared with Alisa variety, while Pb contents in Alisa stems and leaves were higher than them in GS variety show Fig. (6).

4- Heavy Metal Contents in Two Varieties of Tomato Organs:

4-1- Zinc Contents:

In all treatments, Zinc contents are more than the normal range (10to 100ug/g) reported by Beeson (1941), and Chapman (1973). Also they are in range of toxic levels (100-400ug/g) mentioned by Kabata-Pendias and Pendias (2000), except in Gs stems in case of using 100% chicken manure is less than the normal range. The behaviour of Zinc contents in some organs in case of using 25% chicken manure plus 75% mineral fertilizers are different, the contents of Zn in stems and leaves of Gs variety and Alisa fruits are in normal range (Beeson, 1941, Chapman, 1973), while they are lower than toxic levels mentioned by Kabata-Pendias and Pendias (2000). Zinc contents in other organs of two varieties are more than the normal range and toxic levels.

4-2- Lead Contents:

Lead contents in all organs of two varieties under different treatments are more than the maximum amounts, (5.0 ug/g) normal levels (2.5 ug/g) and toxicity level for livestock (30 ug/g), according to Kirkham (1977), and Chaney (1993), respectively. Also they are more than accepted as safe for human consumption reported by Hapke (1991), while they are in range of toxicity levels (30-300 ug/g) mentioned by Kabata-Pendias and Pendias (2000).

5- Total Fruit Yield:

Fertilization treatments affected total fruit yield of tomato crop statistically. The lowest fruit yield of tomato was obtaind by the addition of mineral fertilization alone (100%) compared with other treatments. Higher and statistical fruit yield was obtaind by the addition of chicken manure alone (100%). The highest fruit yield of tomato fruits was obtained by the addition of half mineral plus half chicken manure treatment. 75% mineral plus 25% chicken manure or 25% mineral plus 75% chicken manure recorded higher and

significant increase in fruit yield compared with mineral fertilization or chicken manure alone. With respect to varieties, it is clear from the data in table (2) that GS12 over yielded Alias in its fruit yield by 22.93 %. These differences were statistical and significant. It could beconcluded that GS12 was superior in its fruit yield than Alisa. Interaction of treatments and varieties indicates that GS12 with variable rates of mineral and chicken manure leads to higher tomato fruit yields.

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