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Behaviour of Trace Elements in Soil and Two Varieties of Tomato under Different Rates of Fertilizers with and without Biofertilizer

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Abstract: Field experiment was carried out to study the effect of biofertilizer and different combination of chicken manure and mineral fertilizers on the behaviour of trace elements (Fe, Cu and Mn) in soil and the different organs of tow varieties (GS12 and Alisa) of tomato plant organs and fruits. Different rates of chicken manure and mineral fertilizers with and without biofertilizer were applied. The obtained results revealed that GS12 variety released available Fe, Cu and Mn in soil by using 100% chicken manure with or without biofertilizer. Also it released Fe, Cu and Mn in case of using 100% mineral and 75% chicken plus 25% mineral fertilizers without biofertilizer. On the other hand, Alisa variety released elements in soil under other treatments. Available iron and manganese were decreasing with growing tomato in soil under different treatments. Chicken manure and mineral fertilizers increased significantly the total yield of tomato. The highest total yield was obtained by 75% chicken manure + 25% mineral fertilizers while the lowest total yield was recorded by 100% mineral fertilizers or 100% chicken manure. Biofertilizer increased significantly the total yield of tomato fruits. The interaction between organic and mineral fertilizers as well as biofertilizer had no significant effect on the total yield of tomato in the two varieties (GS 12 and Alisa).

Keywords: Soil, Trace Elements, Mineral Fertilizers, Chicken Manures, Biofertilizers, Tomato Plants

INTRODUCTION

Tomato *(Lycopersicon esculentum Mill.)* production is greatly influenced by many factors such as cultivars, type of soil, fertilizer rates …etc. There is a general agreement, that of all the nutrients amendments made to the soil, N-fertilizer application had by far the most important effects in terms of increase crop production. Phosphorus is second only to N as the most limiting element for plant growth, integration of croup species and/or crop cultivars that can make most efficient use of the P supplied by the soil and maintenance fertilizer application represents a key element of sustainable cropping systems[1].

Organic manures are well established to be involved in fertilization of plants due to its beneficial effect on the physical, chemical and biological characteristics of the soil. This in turns, influences growth and increase production of plant[2].

Biofertilizers are products containing living cells of different types of microorganisms, which have an ability to convert nutritionally important elements from unavailable to available form through biological processes[3,4]. In recent years, biofertilizers have emerged as an important component of the integrated nutrient supply system and hold a great promise to improve crop yields through environmentally better nutrient supplies. However, the application of microbial fertilizers in practice, somehow, has not achieved constant effects. The mechanisms and interactions among these microbes still are not well understood, especially in real applications[5].

The objective of this study is to determine the effects of biofertilizer and different rates of chicken manure and mineral fertilizers on the behaviour of trace elements in soil and tow varieties of tomato plants.

MATERIAL AND METHODS

This experiment was carried in 2005 summer season at Banha, Qalubia Governorate, Egypt, to study the effect of biofertilizer and the different rates of chicken manure and mineral fertilizers on the behaviour of trace elements in soil and tow varieties (GS 12 and Alisa) of tomato plant organs and yields.

Treatments are as follows:

- 100% chicken manure without and with biofertilizer. (C 100).

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Table 1: The characteristics of soil

Treatment	EC (ds/m)	pH 1-2.5	CaCo3 %	OM %	ESP %	CEC meq/100g	Texture	Available (µg/g)		
								Fe	Cu	Mn
Soil before planting	2.5	8.4	1.4	1.9	13.5	41.5	Clay loam	121	2.7	30.4

Table 2: Trace elements in chicken manure and mineral fertilizers

Fertilizer	Total (µg/g)		
	Fe	Cu	Mn
Chicken manure	2744	1.5	343
Super Phosphate	3321	70	372
Ammonium nitrate	43	3.8	1.1
Potassium Sulphate	200	3.8	3.2

- 75% chicken manure plus 25% mineral fertilizers without and with biofertilizer (C 75 + M 25).
- 50% chicken manure plus 50% mineral fertilizers without and with biofertilizer (C 50 + M 50).
- 25% chicken manure plus 75% mineral fertilizers without and with biofertilizer (C 25 + M 75)
- 100% mineral fertilizers without and with biofertilizer (M 100).

Seeds of two varieties of tomato plants (*Lycopersicon Esculentum* Mill.) GS12 and Alisa were sown in foam trays with growing media of 1 peat: 1vermiculite and were transplanted into field.

Before cultivation, soil samples (0-60 cm) were analyzed for available and total elements. Ammonium acetate- EDTA mixture (pH = 4.65) was used to extract the available elements form[6]. Aqua Regia was used to digest soil samples for total contents of the investigated trace elements[6] .

The design of the experiment was completely randomized with four replicates. The plot area was 11.2 m^2 included 4 ridges, each with 70 cm, width and 4.0 m long.

Chicken manure was analyzed for total trace elements (Fe, Cu and Mn) using mixture of concentrated acids[6]. The normal agricultural treatments of growing tomato were practiced as usually followed in the commercial production of tomato. Chicken manure was added to soil before sowing.

The physical and chemical properties of the experimental soil are found in Table (1). Chicken manure have been investigated and the results are presented in Table (2).

At harvest time, total fruit yield as ton/fed in each treatment was recorded. Also, soil samples were collected to represent each soil treatment to measure the available Cu, Fe and Mn. Plant samples were divided into roots, stems, leaves and fruit and digested by mixture of concentrated acids(6). Iron, manganese and copper were determined in soil and plant organs applying micro-sampling technique. This could overcome the matrix and nebilization difficulties in high salt content sample solutions[7,8].

All the obtained data were subjected to statistical analysis of variance according to the procedure outlined by Gomez and Gomez [9].

RESULTS AND DISSECTIONS

From Fig (1) it is clear that GS12 variety released the available Fe, Cu and Mn in soil by using C100 with or without biofertilizer. Also it released elements in case of using M100 and C75+M25 without biofertilizer, while Alisa variety released elements in soil under other treatments.

Available iron and manganese were decreasing with growing tomato in the soil under different treatments. The contents of available iron in all treatments are more than adequate amounts (4.5 µg/g) according to Follet and Lindsey[10]. Also, they are less than tolerable limit (500 µg/g and 300 µg/g) [11].

According to Follet and Lindsay[10] the available Mn in all treatments are more than the reported value (>1.0 µg/g), while they are less than the maximum tolerable concentration (300 µg/g) [12]. Also, they are in normal range (15 to 1250 µg/g) [13].

The available copper in all treatments is more than adequate (0.2 µg/g)[10], as well as the value of non polluted soils of Egypt, (1.86 to 2.5 µg/g)[14]. Also, they are in range of common concentration (1.0-20 µg/g) and lower than the maximum tolerable concentration (100 µg/g)[12]. The available Cu in all treatments lies in range (0.002 to 180 µg/g) of normal soil[13].

Behaviour of Trace Elements in the Organs of Two Tomato Varieties under Different Treatments:

In Case of Using M100 Without and with Biofertilizer: The behaviour of iron content was different between GS12 and Alisa because it was decreased in GS12 organs except in fruits, while it was increased in Alisa oranges except in roots and stems by using biofertilizer (Figs (2a&b)). Biofertilizer decreased the copper content in GS12 organs except in leaves. Also it decreased the copper content in stems and leaves in Alisa variety, while the biofertilizer increased them in roots and fruits as shown in Figs (3 a&b).

The content of manganese was increased in GS12 leaves, stems and roots but it was decreased in fruit by using biofertilizer. The manganese content was increased in roots and leaves of Alisa variety by using biofertilizer, while it was decreased in Alisa stems and fruits (Figs (4 a&b)).

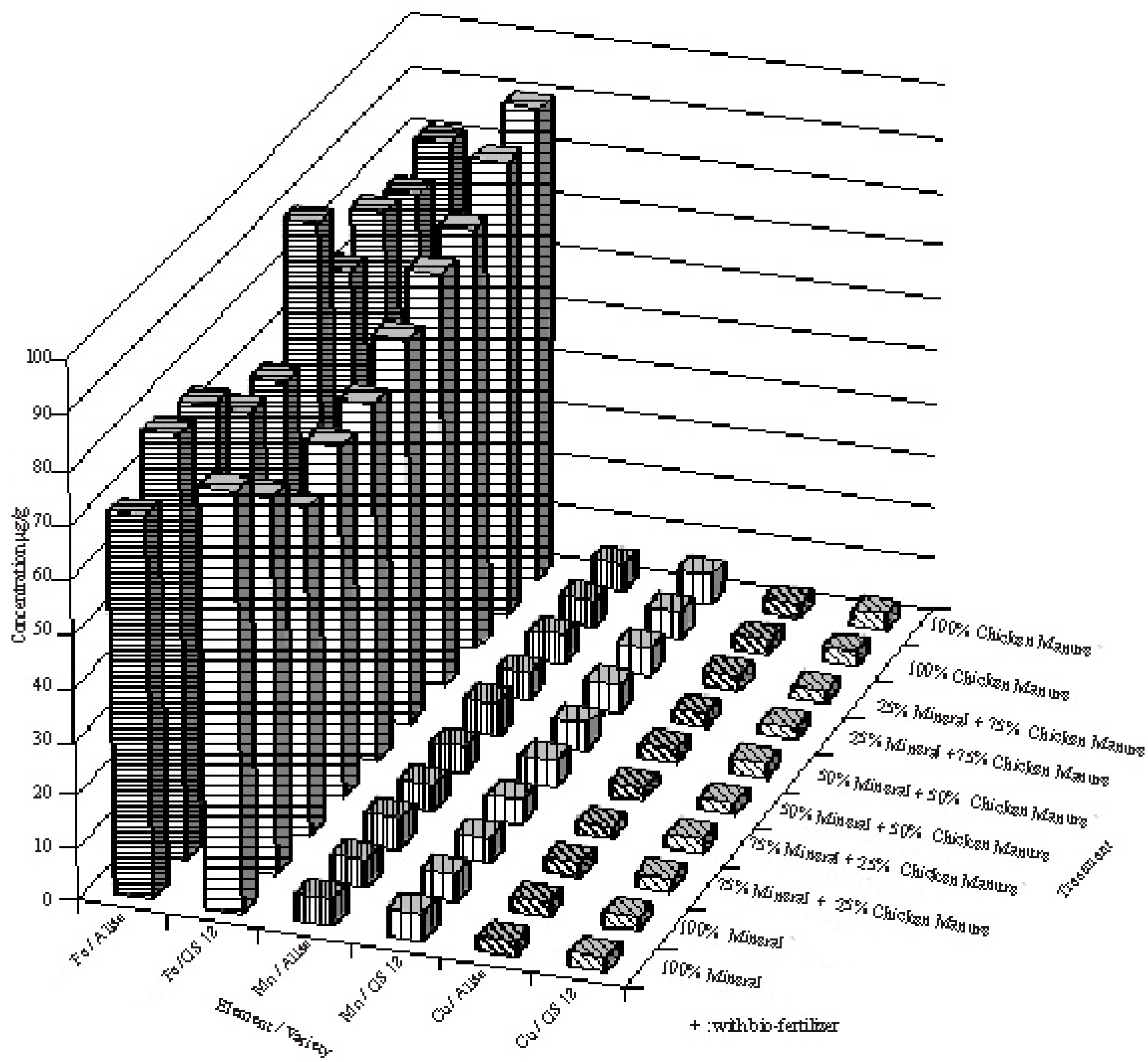


Fig. 1: The concentration of trace elements in soil under different treatments.

In Case of Using M75 + C 25 Without and with Biofertilizer: Biofertilizer decreased the iron content in GS12 and Alisa organs except in stems and leaves of GS12 and Alisa respectively, Figs (2a&b).

The content of copper was decreased in all organs of GS12 variety while they were increased in roots and fruits of Alisa variety by using biofertilizer, Figs (3a&b).

Figs (4a&b) show that the manganese content was decreased in all organs of GS12 variety except in roots while it was increased in all Alisa organs except in stems by using biofertilizer.

In Case of Using M50 + C 50 Without and with Biofertilizer: Figs (2a&b) show that biofertilization increased iron content in GS12 stems and leaves while it was decreased in all Alisa organs. Biofertilizer increased the copper content in all GS12 organs except in leaves; also the content of copper was increased in Alisa stems and fruits Figs (3a&b). The content of manganese was increased in GS12 stems and fruits while it was decreased in all Alisa organs, Figs (4a&b), by biofertilizer application.

In Case of Using M25 +C 75 Without and with Biofertilizer: From Figs (2a&b), it is clear that the iron content was increased in all organs of the two varieties except in Alisa stems by using biofertilizer. Figs (3a&b) show that biofertilizer application decreased the copper content in stems, leaves and fruits of Alisa variety also it was decreased in stems and fruits of GS12. The manganese content was increased in all organs of the two varieties except in GS12 stems and Alisa fruits as shown in Figs (4a&b).

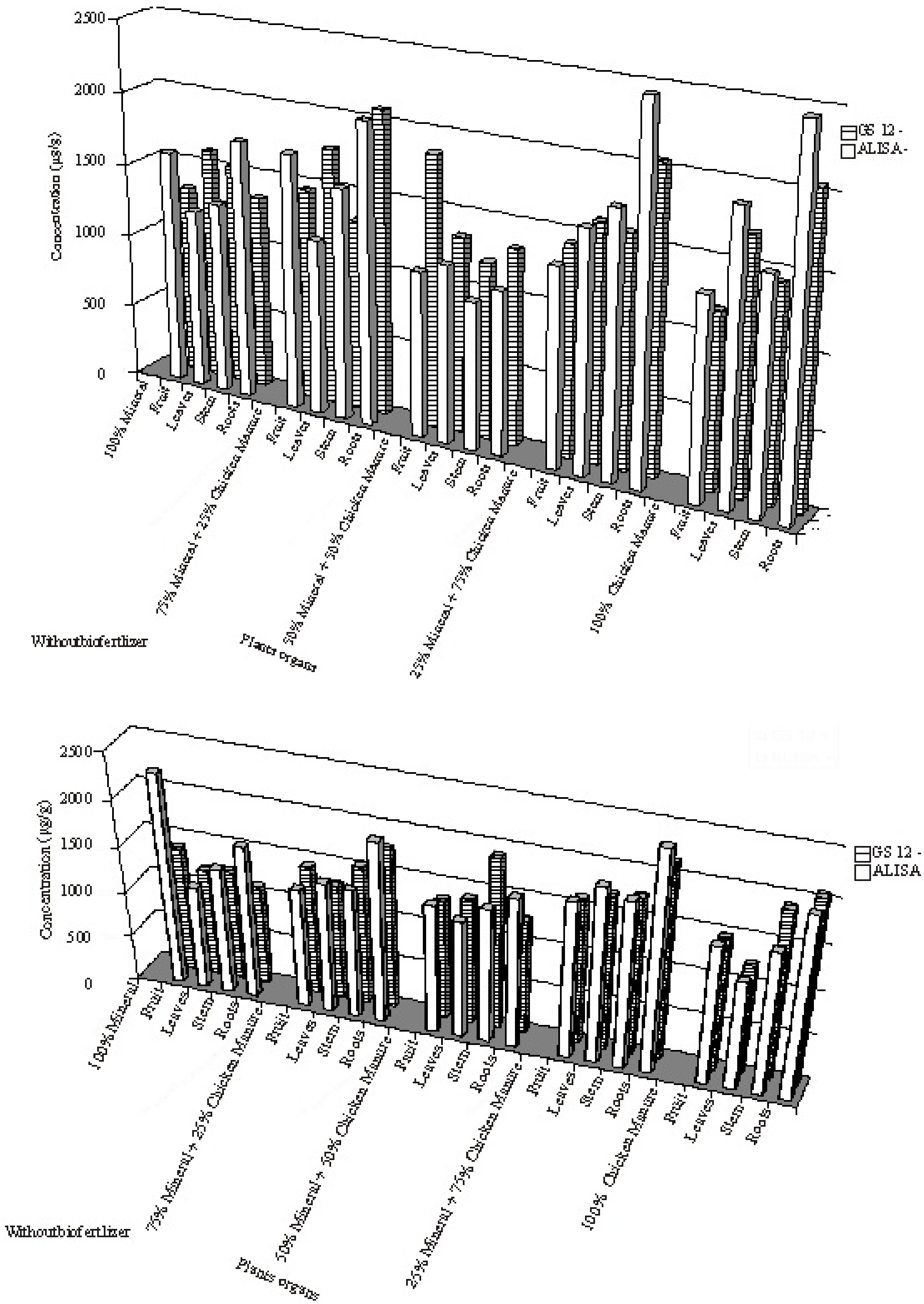
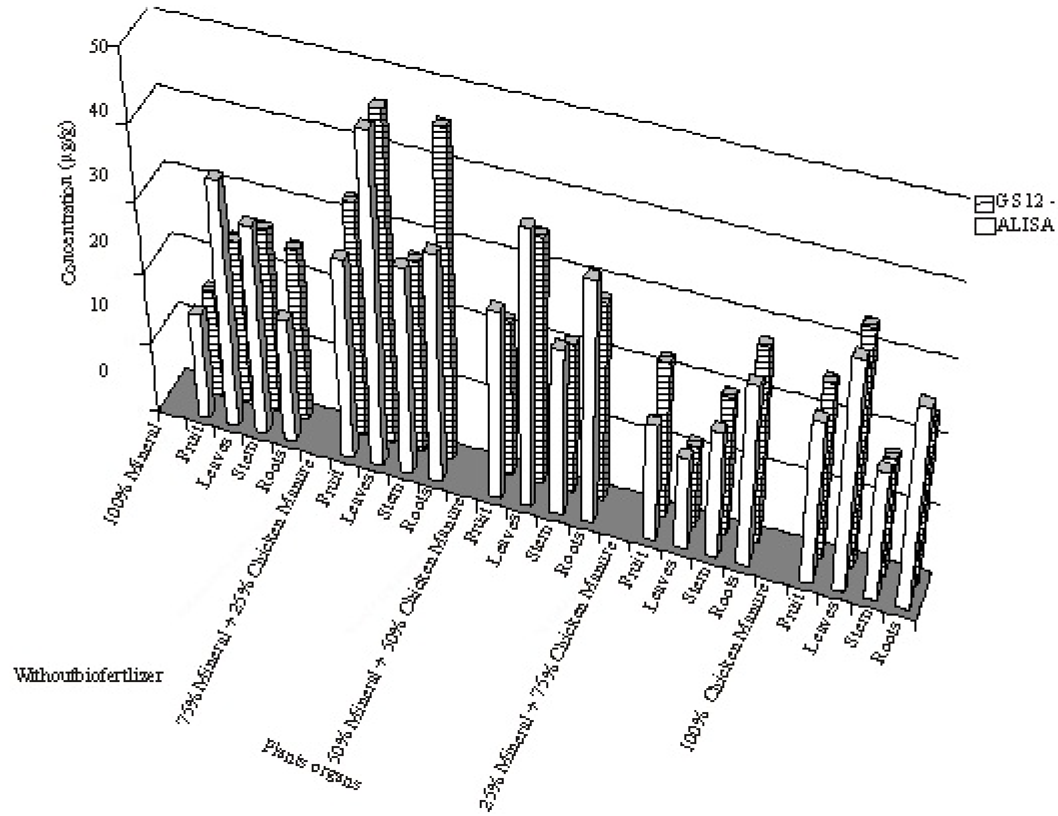


Fig. 2a&b: Concentration of Fe in two varieties of Tomato organs under different treatments



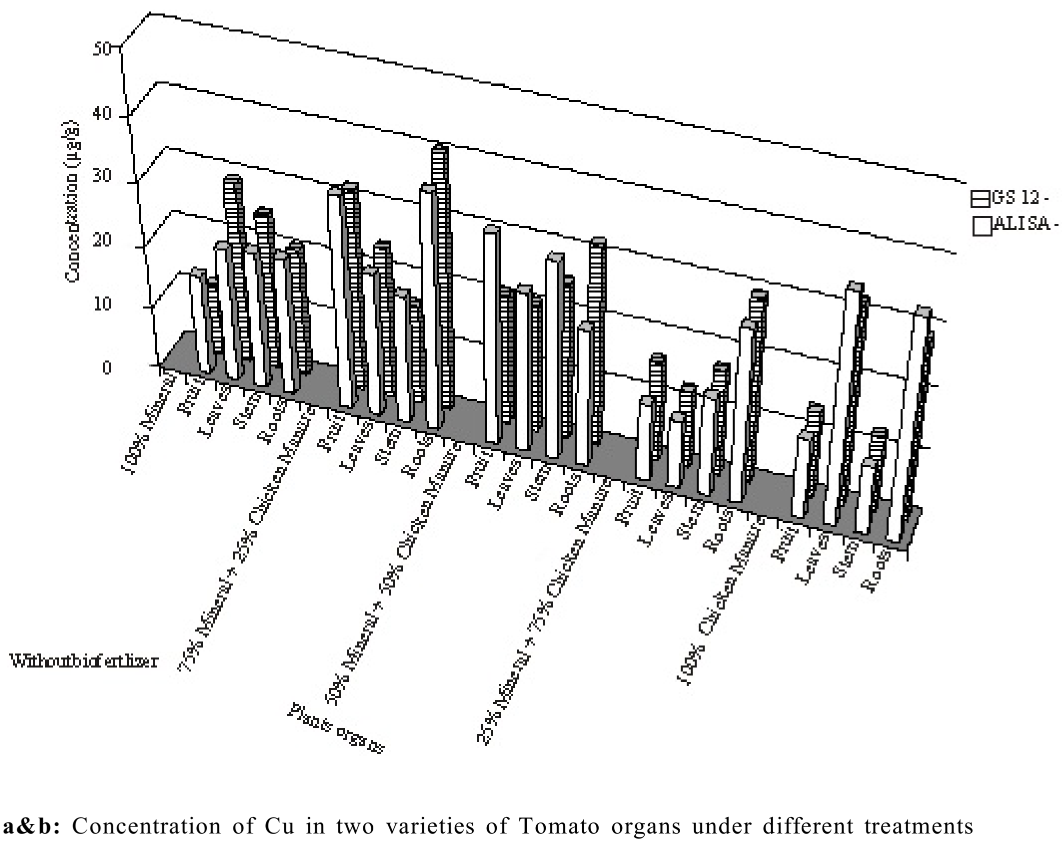


Fig. 3a&b: Concentration of Cu in two varieties of Tomato organs under different treatments

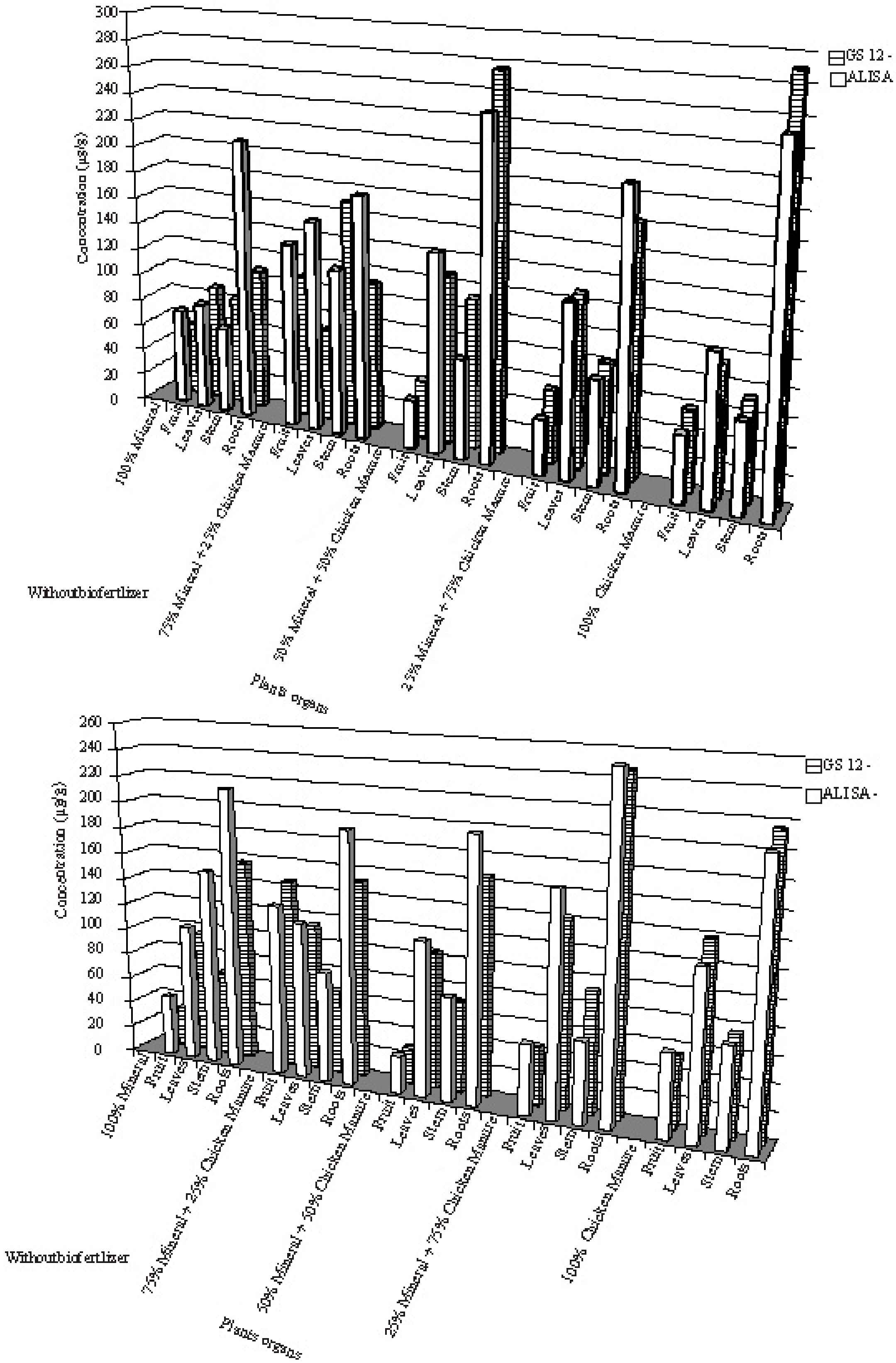


Fig.4a&b: Concentration of Mn in two varieties of Tomato organs under different treatments

Table 3: The effect of different treatments on total yield

Treatment		Biofertilizer	Total yield (Ton/Fed) GS12	Alisa
Effect of biofertilizer		Without	23.48	19.1
		With	23.88	20
	LSD		0.22	0.19
Effect of different rates of mineral fertilizers and chicken manure	M 100		22.9	18.4
	M75 + C25		24.15	19.25
	M 50 +C 50		24.25	19.6
	M 25+ C75		24.45	20.1
	C 100		21.65	17.85
	LSD		1.07	1.21
Effect of interaction	M 100		23.9	18.7
	M75 + C25		24.1	19.4
	M 50 +C 50		23.6	20.4
	M 25+ C75	Without	24.4	19.4
	C 100		21.4	17.6
	M 100		24.4	19.8
	M75 + C25		24.8	20.8
	M 50 +C 50	With	23.9	20.7
	M 25+ C75		24.4	20.61
	C 100		21.9	18.1
	LSD		NS	NS

In Case of Using C100 Without and with Biofertilizer: From Figs (2a&b) it is clear that biofertilizer application increased the iron content in GS12 organs except in leaves, while it decreased the iron content in Alisa organs except in stems. Figs (3a&b) show that the content of copper was decreased by using biofertilizer in GS12 organs except in roots, while it was increased in roots and fruits of Alisa variety. Using the biofertilizer increased the manganese content in GS12 and Alisa organs except in roots and fruits of GS12 and Alisa respectively, Figs (4a&b).

Comparison Between Iron Content in the Different Organs of Tow Tomato Varieties and the International Level: The content of iron in all organs of the two tomato varieties is more than the normal concentration (25 or 30 to 300 µg/g)[14-16]. Also it is more than the critical toxicity (400-1000 µg/g in plant tissues)[17]. The iron content is more than the maximum level tolerable by cattle, chicken (1000 µg/g) and sheep (500 µg/g)[16].

Comparison Between Copper Content in the Different Organs of Tow Tomato Varieties and the International Level: Copper content in most organs of the two tomato varieties under all treatments is in normal range (4 to 40 µg/g) [15,16]. Also it is more than the normal levels (3-20 µg/g dry foliage)[17], while it is in range of phytotoxic levels (25-40, 10-70 and 20-100 µg/g)[17,19,20]. The content of copper in most organs of two varieties under different treatment is more than the maximum level tolerated (25 µg/g) by sheep[17].

Comparison Between Manganese Content in the Different Organs of Two Tomato Varieties and the International Level: The manganese content in all organs of the two varieties under different treatments is in normal range (35–300 µg/g)[15,16].

Yield and its Quality:

Effect of Type and Rates of Fertilizers: The results reported in Table (3) demonstrate clearly that, using chicken manure and mineral fertilizers increased significantly total yield of tomato. The highest total yield was obtained by C 75 + M 25. These results were true in the two varieties (GS 12 and Alisa). Meanwhile, the lowest total yield was recorded by using M 100 or C 100. The increase in the total yield resulting by chicken manure may be attributed to that chicken manure enhanced soil aggregation, soil aeration and increasing water holding capacity and offers good environmental conditions for the growth and development of the root system of tomatoes. In addition, organic manures are slow release nutrients allover the growth season. Chicken manure is rich in its nitrogen and nutrients content. These favorable conditions creates better nutrients absorption and favors the growth and development of root system which in true reflects better vegetative growth, photosynthetic activity and dry matter accumulation. Consequently higher total yield would be obtained by chicken manure. Similar results were obtained by other investigators)[21,22].

Effect of Biofertilizer: Data presented in Table (3) indicated that, using biofertilizer increased significantly the total yield of tomato fruits. These results were similar and true in the two varieties (GS12 and Alisa). The highest total yield with biofertilizer was 20.0 and 23.88 ton/fed to Alisa and GS12 compared with 19.10 and 23.48 ton/fed without biofertilizer, respectively.

The obtained results are in good accordance with those which were reported by Wang[23] and Abd El-Hafeze and Shehata[24].

Effect of the Interaction: Results in Table (3) indicated that the interaction between chicken manure and mineral fertilizers as well as biofertilizer had no significant effect on the total yield of tomato in the two varieties (GS12 and Alisa). These results were true and similar indicate that, each factor of the treatments act independently.

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