The Distribution of Heavy Metals in Soil and Squash Organs Under Different Rates from Poultry Manure and Biofertilizer

A.E. Malak Ramadan, S.M. Adam and Z.F. Fawzy

1Department of Soil and water use, National Research centre, Dokki, Cairo, Egypt.
2Departement of Vegetable Crops, National Research centre, Dokki, Cairo, Egypt.

Abstract: Field experiment was carried out during the growth successive season at Banha (Qalubia Governorate). Squash seeds were sown to investigate the effect of three rates of poultry manures (100%, 75% and 50%) and nitroben biofertilizer (with or without) on distribution of heavy metals in soil and two varieties (Fransawy Fransawy and Mabroka) of squash organs growth and yield. In case of using biofertilizer, the available Fe and Pb were increasing in soil. Fransawy variety released the heavy metals in soils more than mabroka variety in all treatments. The highest contents of available iron were found in soils in case of using 100% chicken manure followed by 50% chicken manure and 75% chicken manure, with or without biofertilizers treatment. High content of iron was found in mabroka fruit than fransawy fruit in the 100% chicken manure in presence and absence of the biofertilizer treatments. In case of using 100% chicken manure without biofertilizer, the high contents of lead were found in mabroka fruit and leaves also in Fransawy stem and roots. Also high contents of lead were found in fransawy organs in case of using 100% chicken manure plus biofertilizers then using 75% chicken manure. High contents of iron were found in mabroka organs except the leaves than Fransawy organs in two treatments. In case of using 75% chicken manure with biofertilizers the lowest lead contents were found in mabroka organs. By using 50% chicken manure without biofertilizers, the high contents of iron were found in Mabroka organs. The biofertilizers decreased the iron contents in Mabroka organs except in leaves while it increased the iron contents in Fransawy organs. By using 50% chicken manure without biofertilizers, the high contents of lead were found in Mabroka organs. Biofertilizers increased the lead contents in mabroka organs except in stem. The lowest yield of squash plants was recorded by Mabroka variety. The highest total yield was produced by using biofertilizer.

Key words: Heavy metals, Squash plant, Soil, Bio-fertilizer, Chicken Manure

INTRODUCTION

Pollution of the natural environment by heavy metal is a worldwide problem because these metals are indestructible and most of them have toxic effects on living organisms, when they exceed a certain concentration according to Nuremberg[1], Forstner[2], Harte et al. [3], Schuermann and Market [4], Mac Farlane and Burchett [5]. Heavy metals are of ecological significance since they are not removed from water as a result of self purification but accumulate in reservoirs and enter the food chain [6]. Excessive application of chemical fertilizer in agricultural soil had caused serious environmental problems including deteriorate soil physical structures nutrients unbalance of soil and water eutrophication [7]. Livestock and poultry manure can be an alternative source of fertilizer in organic farming where the use of anthropogenic chemicals is prohibited [8,9]. Meanwhile, it is an economic method to use the manures rather than chemical fertilizer and also can avoid environmental pollution of manure in areas with high livestock and poultry densities caused by inappropriate disposing. It is well known that manures were rich in N, P and organic matter and many studies showed that livestock and poultry manures densities caused by inappropriate disposing. It is well known that manures were rich in N, P and organic matter and many studies showed that livestock and poultry manures exercised appositive influence on crop production and they also improved soil physical properties according to Woodbury [10], McConnell et al. [11], Guisquiani et al. [12], Tam and Wong [13] and Chen et al. [14].

The aim of this work is to study the effect of three rates of poultry manure (100%, 75% and 50%) with or without biofertilizer (Nitroben) on the distribution of some heavy metals in soil, squash organs and yield.

MATERIALS AND METHODS

Field experiment was carried out during the growth successive season at Banha (Qalubia Governorate). Squash seeds were sown to investigate the effect of
three rates of poultry manures (100%, 75% and 50%) and nitroben biofertilizer (with or without) on distribution of micronutrient in soil and two varieties (Farnsawy and Mabroka) of squash organs growth and yield. The physical and chemical properties of the experimental soil and poultry manure are presented in Table (1). The design of the experiments was split-plot with four replicates, where the poultry rates were distributed in the main plots and the bio-fertilizer treatments were arranged 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. The normal agricultural treatments of the growing squash were practiced as usually followed in the commercial production of squash. The bio-fertilizers were added under the plants, 15 days after sowing.

Chicken manure was analyzed for total metals (Fe and Pb) using mixture of concentrated acids\(^{[14]}\).

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\(^{[14]}\). Aqua Regia was used to digest soil samples for total contents of the investigated heavy metals\(^{[14]}\). At harvest time, soil samples were collected to represent each soil treatments to measure the available Fe and, Pb. Plant samples were divided into roots, stem, leaves and fruit and digested by mixture of concentrated acids\(^{[14]}\). Iron and lead were determined in soil and plant applying micro-sampling technique. This could overcome the matrix and nebulization difficulties in high salt sample solution\(^{[15a,16b]}\). Squash fruits were harvested twice every week. At harvest time the total weight of fruits in each treatment was recorded and the total yield as ton/ fed was accounted. All the obtained data were subjected to statistical analysis of variance according to the producer outlined by Gomez and Gomez\(^{[17]}\).

## RESULTS AND DISCUSSIONS

1-The Different Status of Heavy Metals in Soils

### Before Cultivation:

Table (1) reveals that total Fe, is higher than the value 25000µg/g respectively. On the other hand, the total Pb is lower than the reported value (100 µg/g) according to Cottene\(^{[14]}\). The total Pb is lower than total amount (50 µg/g) mentioned by Ewers\(^{[18]}\).

Fig. (1) shows that the available Pb is within the common concentration range, but lower than the maximum tolerable concentration according to Ewers\(^{[18]}\). The available Fe is lower than tolerable limit (500 ppm soil) mentioned by Tietjen\(^{[19]}\). Also the measured values are higher than adequate amount (4.5ppm) according to Follet and Lindsay\(^{[20]}\).

The amount of available Pb is in the range of international criteria (0.5 to 135 ppm) according to Souza \textit{et al}\(^{[21]}\) and lower than the critical level (100 to 400 ppm) mentioned by Kabata – Pendias and Pendias\(^{[22]}\). Also it is in range of common concentration (0.10 – 20 ppm) and lower than maximum tolerable concentration.

![Graph](image.png)

**Fig. 1:** The concentration of available elements in soil under different treatment.
Fig. 2: The behavior of heavy metal in plant organs in case of using 100% Chicken manure with and without biofertilizers

(100 µg/g) according to Ewers\(^\text{[18]}\). According to Aboulroos et al\(^\text{[23]}\), the available Pb is more than the background level of extractable Pb in nonpolluted soils of Egypt (1.17 to 1.61 ppm).

2-The Concentrations of Available Elements in Soil under Different Treatments: Fig. (1) shows that Fransawy variety can release the heavy metals in soils more than mabroka variety in all treatments. The contents of available iron were higher by using 100% chicken manure with or without biofertilizers than 50% it was lowest by using the 75%. The available Fe is lower than tolerable limit reported by Tietjien\(^\text{[19]}\), while it was more than nonpolluted soil mentioned by Kirkham\(^\text{[24]}\). Also it was found that the measured values are more than adequate amount according to Follet and Lindsay\(^\text{[26]}\).

The available Pb in the range of common concentration and less than maximum tolerable concentration according to Ewers\(^\text{[18]}\). It was less than the critical level mentioned by Kabata-Pendas and Pendas\(^\text{[25]}\). The amounts of available Pb were within the range of international criteria according to Souza et al\(^\text{[21]}\). According to Aboulroos et al\(^\text{[23]}\), mentioned that the available Pb is more than the background level.

3-The Behaviour of Heavy Metals in Two Varieties of Squash Organs under Different Treatments: 3-1- In Case of Using 100% Chicken Manure Without and with Biofertilizer: Fig. (2) shows that the content of iron is higher in Mabroka fruit than Fransawy fruit in the two treatments. The iron content in other organs of Mabroka variety is lower than the iron content in Fransawy organs. The content of iron is higher than the normal concentration (25 or 30 to 300 ppm) according to Beeson\(^\text{[22]}\), Chapman\(^\text{[26]}\) and Chaney\(^\text{[27]}\), except the Fransawy fruit in the two treatments. The iron contents are higher than the critical toxicity (400-1000 ppm in plant tissues) as mentioned by Romheld and Marschner\(^\text{[29]}\). Also they are higher than the maximum level tolerated by cattle (1000 ppm), sheep (500 ppm) and chicken (1000 ppm), as reported by Chaney\(^\text{[27]}\).

By using 100% chicken manure without biofertilizer, the contents of lead are higher in mabroka fruit and leaves. The same behaviour was in Fransawy stem and roots. The highest contents of lead are found in Fransawy organs by using 100% chicken manure plus biofertilizers (Fig 2). Lead contents in all organs of the two varieties are more than the maximum amounts of Pb that occur in plant under nonpolluted condition (5.0 ppm) Kirkham\(^\text{[24]}\). It is more than the normal levels (2-5 ppm dry foliage) and toxicity level for livestock (30 ppm) according to Chaney\(^\text{[27]}\). Also they are in the range of toxicity level (30-300 ppm, Kabata-Pendas and Pendas\(^\text{[25]}\) and more than conservative threshold value (3000 ppm) accepted as safe for human consumption\(^\text{[30]}\).

3-2- In Case of Using 75% Chicken Manure Without and with Biofertilizers: The highest contents of iron were found in Mabroka organs except the leaves then Fransawy organs in the two treatments. Iron contents are higher than the normal concentration reported by Beeson\(^\text{[22]}\), Chapman\(^\text{[26]}\) and Chaney\(^\text{[27]}\). The contents of iron in some organs are in the ranges of critical toxicity as mentioned by Romheld and Marschner\(^\text{[29]}\). Also they are higher or less than the maximum level tolerated by cattle, sheep and chicken, according to Chaney\(^\text{[27]}\), show Fig. (3).
By using 75% chicken manure with biofertilizers the minimum lead contents were found in Mabroka organs. (Fig 3). Lead contents in all organs of the two varieties were more than the maximum amount of Pb that occur in plant under nonpolluted condition Kirkham[24], more than normal levels and toxicity level for livestock as mentioned by Chaney[23]. Also they are in the range of toxicity level Kabata-Pendias and Pendias[25] and more than conservative threshold value accepted as safe for human consumption[26].

Similarly, in case of using 50% chicken manure without and with biofertilizers, the highest contents of iron were found in Mabroka organs. The biofertilizers are decreasing the iron contents in Mabroka organs except in leaves, while it is increasing the iron contents in Fransawy organs (Fig 4). All contents of iron are more than the normal concentrations Beeson[27], Chapman[28] and Chaney[29]. The iron contents are in ranges or more than the critical toxicity reported by Romheld and Marschner[30].
The effect of different treatments on total yield.

<table>
<thead>
<tr>
<th>Effect of Variety</th>
<th>Treatment</th>
<th>Variety</th>
<th>Total Yield (Ton/Fed)</th>
<th>LSD</th>
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<td>Mabroka</td>
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<td>Effect of Interaction</td>
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<td>Fransaw</td>
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Also they are less or more than the maximum level tolerated by cattle and chicken, but more than the maximum level tolerated by sheep as mentioned by Chaney [27]. By using 50% chicken manure without biofertilizers, the highest contents of lead were found in mabroka organs. Biofertilizers are increasing the lead contents in Mabroka organes except in stems. Also they are increasing in Fransawy organs. Lead contents are more than the maximum amounts of Pb that occur in plant under nonpolluted condition Kirkham[24], more than normal levels and toxicity level for livestock as mentioned by Chaney[27]. Also they are in the range of toxicity level Kabata-Pendias and Pendias[29] and more than conservative threshold value accepted as safe for human consumption reported by Hapke[30] show Fig. 4.

4-2 The Effect of Different Rates from Chicken Manure: Application rates from chicken manure increased the total yield of squash plants (Table 2). It was found that the highest yield of squash plants was recorded by 75% chicken manure with Fransawy variety and 100% chicken manure with Mabroka variety. The lowest yield of squash plants was found by application with 50% chicken manure.

4-3 The Effect of Interaction: Table (2) presented the effect of the interaction between different rates from chicken manure and the total yield of squash varieties. There were no insignificant effect on the total yield of squash varieties. The highest values were recorded in case of using 100% chicken manure plus biofertilizer by Fransawy variety. The lowest total yield was found in case of using 75% chicken manure without biofertilizer by mabroka.

4-4 The Effect of Biofertilizer: Results found in table (2) show that there were significant difference between the total yield of squash plants and using biofertilizer. The highest total yield was produced by using biofertilizer.

REFERENCE


