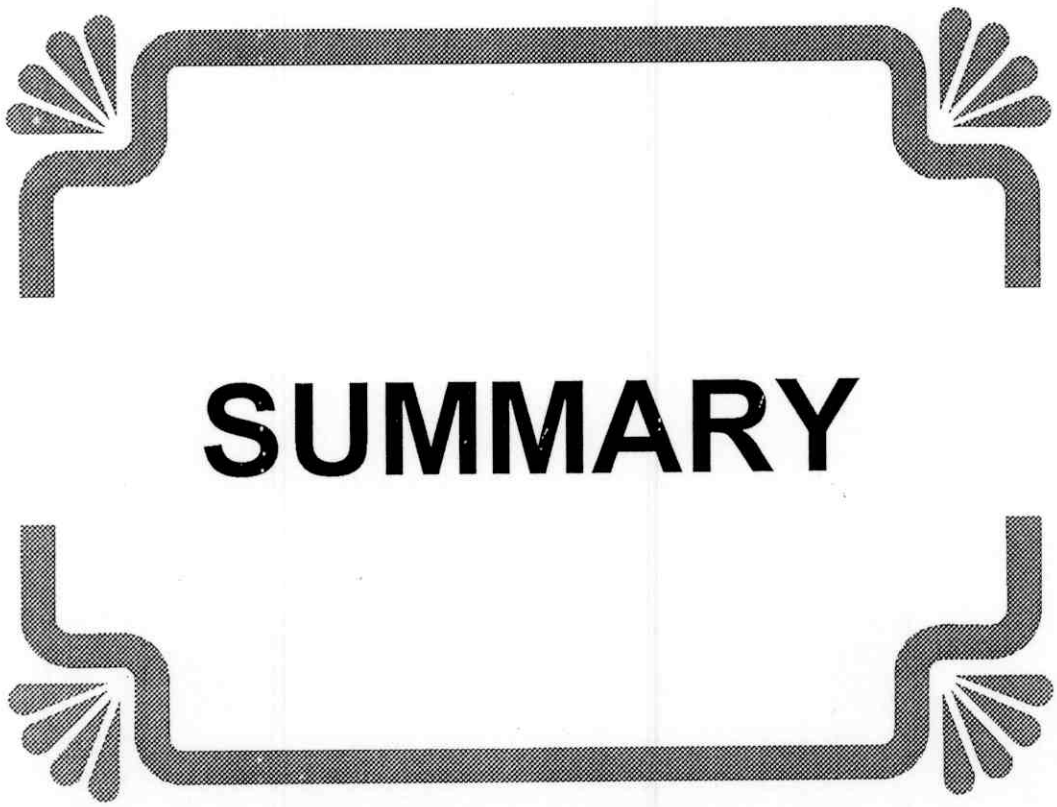

SUMMARY

5. SUMMARY

The current work was carried out to (i) investigate the effect of sewage sludge application on soil macro-micronutrients and heavy metals contents in rhizosphere of corn and faba-bean plants and their uptake by their crops. (ii) evaluate the effect of sewage sludge application on rhizosphere biological activity, nitrogen fixation and the pathogenic bacteria in ecosystem.

To fulfill these purposes, two experiments were carried out in greenhouse of Soils, Water and Environment Research Institute, Agricultural Research Center, Giza. In these experiments, each pot was uniformly packed with ten-kilogram portions of the investigated soil mixed with sewage sludge treatments. Each treatment was replicated three times. The treatments included the following rates, 0, 15, 30, 60 and 90 g/kg soil in equal dose 0, 5, 10, 20 and 30 m^3 fed^{-1}, respectively. The studied soil was collected from Abu-Rawash. Sewage sludge was collected from Abu-Rawash Waste Water Treatment plant (about 26 km from Cairo). The first experiment was carried out in summer season (1998) using corn (c.v. Giza 2) and the second experiment was carried out in winter season (1998 / 1999) using faba-bean (vicia, faba, c.v.Giza 420) as indicator plants.

The results obtained could be summarized as follows:

1- The DTPA extracted heavy metals in sewage sludge were in the order 125.9, 22.5, 18.4, 14.6, 13.49 and 0.02 mg kg^{-1} for Fe, Zn, Mn, Pb, Cu and Cd, respectively. While the total

heavy metals in the order 19000, 423.3, 211.6, 144.6, 115.1 and 8.66 mg kg^{-1} for Fe, Pb, Zn, Mn, Cu and Cd, respectively.

2- The sewage sludge had a high percentage of total organic matter (42.2 %) and high N, P and K content (2.18 %, 0.595 % and 0.434 %, respectively).

3- The pathogenic bacteria in dried sewage sludge were 86 $\times 10^6$, 56 $\times 10^4$ CFU g^{-1} dry matter for total ***Coliform***, ***Salmonella & Shigella*** bacteria and 0.0 N_2-fixers, respectively.

4- The available Fe in the rhizosphere of corn plants were 2.3, 7.0, 18.3, 27.0 and 29.0 mg kg^{-1} and the corresponding values under faba bean plants were 4.9, 20.2, 39.38, 33.2 and 50.5 mg kg^{-1} for soil treated with sewage sludge at rates of 0, 5, 10, 20 or 30 m^3 fed^{-1}, respectively.

5- Concerning the average values of available Zn in soil treated with sewage sludge at rates of 0, 5, 10, 20 or 30 m^3 fed^{-1} in the rhizosphere of corn plants were 0.96, 2.6, 5.4, 6.8 and 7.06 mg kg^{-1}, while the corresponding values in the rhizosphere of faba-bean plants were 1.63, 6.56, 17.8, 20.6 and 20.7 mg kg^{-1}, respectively.

6- The average values of available Cu in the rhizosphere soil treated with sewage sludge were varied from 0.5 to 6.14 and 0.26 to 7.08 mg kg^{-1} in the rhizosphere for corn and faba-bean plants, respectively.

7- The soil available Pb increased by increasing rates of sewage sludge application.

8- The highest concentration of Cd was less than 1.0 mg kg^{-1} which is considered the maximum concentration permissible for arable lands.

9- The values of available Fe, Mn, Zn, Cu, Pb and Cd in the rhizosphere of corn or faba-bean plants were significantly increased by increasing sewage sludge application.

10- The soil pH values were decreased by increasing sewage sludge application in rhizosphere zone of the soil of corn or faba-bean plants compared with the control treatment (not treated with sludge). However, values of soil pH in the rhizosphere of faba-bean plants decreased than those of corn plants in all experimental periods.

11- The effect of sewage sludge addition on biological activity in the rhizosphere zone of the investigated soil was represented by CO_2 in soil. In general, CO_2 significantly increased during the growth period of corn plants, while these values were decreased after 45 days from planting date of faba-bean plants grown in pots treated with sewage sludge at the rate of 5 and 20 m^3 fed^{-1}.

12- The nitrogen fixation significantly increased by increasing time of experiment at all rates of sewage sludge application as compared with the control treatment.

13- A highly significant positive correlation were found between CO_2 and nitrogenase activity ($r = 0.9$) in corn plant and ($r = 0.87$) in faba-bean plant

14- The total counts of ***Coliform*** and ***salimonella & shigella*** groups were rapidly decreased by increasing the growing period of corn or faba-bean plants. However, the

Coliform numbers were much higher than ***Salmonella*** and ***Shigella***. It's rate of disappearance was after 15 days from sowing, no ***Coliform and Salmonella & Shigella*** bacteria in rhizosphere soil were not detected in soil treated with sewage sludge rates after 45 days of sowing corn and faba-bean plants.

15- Application of sewage sludge significantly increased the total content of N in leaves and these increases were increased by increasing rate of sewage sludge application.

16- The concentration of P in corn leaves ranged from 0.066 to 0.131 % and from 0.109 to 0.358 % in faba-bean leaves. The results indicate that application of sewage sludge significantly increased the P content in leaves except using 30 m^3 fed^{-1}.

17- The concentration of K ranged between 0.1 and 0.15 % in the leaves of corn and faba-bean plants. Increasing the rate of application of sewage sludge to soil, K content increased in the leaves of both corn and faba-bean plants.

18- The application of sewage sludge caused an accumulation of Fe in plants. The degree of accumulation was different according to plant species and the organism analysed.

19- Total Fe, Mn, Zn and Cu in corn and faba-bean plants significantly increased with increasing sewage sludge rates added to soil. The content of Cu in faba-bean plants was higher than in corn plants. But, Fe content in corn plants was higher than that in faba-bean plants.

20- The Pb and Cd contents in corn and faba-bean plants were significantly increased with increasing sewage sludge rates

added to soil. Pb and Cd contents were higher than the normal level.

From the abovementioned results, it can be concluded that sludge should improved soil characteristics and increased the soil contents of macronutrients, heavy metals, the count of ***feacal coliform*** bacteria and the growth of corn and faba-bean. Also, the soil biological activities in ecosystem rhizosphere was increased.

On the other hand, the increase of soil heavy metal contents, more than the permissible levels subsequently increase the contents of heavy metals in leaves of the plant and this may affect on the human consumption. However, these accumulations of heavy metals were varied and depend on cultivar. So, the presence of these pollutants in sewage sludge restricts its agricultural use. Therefore, sludge should be received the proper treatment before utilization to agricultural land.

Therefore, it is necessary to use sewage sludge at a proper rate to avoid this pollution. Nowadays, there is the biogas technology as a simple and effective means for the biotreatment of waste water to produce energy and a safe and clean organic manure. Also, this manure will be free from pathogenic bacteria. Besides, cropping edible plants on soils treated with sewage sludge should be avoided, instead, planting woody trees may be economically of great concern.