SUMMARY

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The aim of this investigation was to study (i) the effect of using sewage effluents and industrial waste water in irrigation on the physical and chemical properties of soil and its content of Cu, Zn, Pb, Cd, Ni and Co, (ii) the effect of industry fall-out derived from some chemical plants and smelters on the status of the tested heavy metals in the neighboring soils, (iii) the effect of motor vehicle exhausts on the total and forms of heavy metals in the roadside soils, and (iv) the contamination of plants with the above mentioned heavy metals.

To achieve the first objective, three locations in El-Gabal El-Asfar represent soils irrigated with sewage effluents for 0, 20 and 60 years and another two locations at Bahteem representing soils irrigated with industrial waste water were selected. Soil samples from five different depths from each profile namely, 0-5, 5-10, 10-25, 25-60 and 60-100 cm and correspondence plant samples were collected.

To accomplish the second objective, five different chemical plants and smelters were selected and two profiles were dug around the source, the first one was on a 5m away and the second was 100 m away from the source of pollution. Soil samples were taken from the different depthes as mintioned above and samples from the plants grown on the different locations were collected.

The third objective was fulfilled through collecting soil and plant samples from six locations differing in their distance and direction from the motor way.

The physical and chemical properties of selected soils were determined. The total content, DTPA-extractable and fractions of Cu, Zn, Pb, Cd, Ni and Co in soil samples were measured. The fourth objective was largely met through the determination of heavy metals in plant samples. The obtained results could be summarized as follows:

The effect of using sewage effluentes and industrial waste water in irrigation on the physical and chemical properties of soils was obvious and the most affected soil properties were soil organic matter, soil pH, CEC, exchangeable cations and total soluble salts, wherase the other properties were less affected. With increasing the peroid of irrigation, soil organic matter was increased, but soil pH and total soluble salts were decreased.

1-Copper

soil content of copper was relatively high in soils received sewage water for 60 years and ranged from 1 to 475 mg/kg soils, DTPA-extractable Cu varied from 0.1, to 24.4 mg/kg soil, while the distribution of Cu among various fractions followed the following order:
Residual > organically bound (Cu-PYR > Occluded on Fe, Al and Mn Oxides (Cu-Ox + Cu-OXA + Cu-HAH) > specifically adsorbed (Cu-AC)> soluble + exchangeable (Cu-CA).

Copper in soils exceeded the maximum tolerable level in site 3 irrigated with sewage water for 60 years, as well as in sites 4 and 5 irrigated with industrial waste water. However, in soils around smelters, the content of Cu was comparable with that of the maximum tolerable level. The concentration of Cu in the correspondence plants grown on soils irrigatedfor

60 years, soils around smelters and soils adjacent to the highway tended to be toxic.

2-Zinc:

The content of zinc in soils was generally high easpecially in soils of El-Gabal El-Asfar. Total Zn ranges from 11 to 1075mg/kg soil, while DTPA-extractable Zn being from 0.22-5000 mg/kg soil. The distribution of Zn among the chemical fractions was followed this order: Residual > Organically bound > Occluded on Fe, Al and Mn Oxides > specifically adsorbed > soluble + exchangeable.

Total Zn in soils surpassed the maximum tolerable level in profile 3 (soils irrigated with sewage effluents for 60 years), while around the smelters (profiles 12,13), the concentration of Zn was relatively high and beyond the maximum level (30 mg/kg). Zn concentration in the growing plants was within the permissible level with a slight increase in those grown on soils irrigated for 60 years.

3-Lead:

Total Pb in soils and DTPA-extractable Pb ranged from 13 to 226 and from 0.02 to 19.0 mg/kg, respectively. The distribution of Pb among the different chemical forms followed this order, Residual > PYR > specific adsorbed > Occluded on Fe, Al and Mn oxides > soluble + exchangeable.

Total Pb in soils around the chemical plants and in those adjacent to the highway is still within the permissible level. However, in soils irrigated with sewage effluents for 60 years (profile 3), Pb has exceeded the threshold value of 100 mg/kg soil.

Soils of profiles 4 and 5 irrigated with industrial waste waters contain high amount of Pb comparable to that reported as threshold value (100 mg/kg soil).

The concentrations of Pb in plants grown on soils irrigated with sewage effluents were highly polluted especially in profile (3). Plants grown on soils adjacent to the highway contained higher amounts of Pb and there is a tendency to reach the higher level of the critical toxicity range (10-20 μg/g).

4-Cadmium:

Cadmium content in soils was generally high in all investigated soils. Total Cd content ranged between 3.0 to 13 mg/kg soil, while DTPA-extractable Cd varies from 0.01 to 1.4 mg/kg soil.

Total Cd in the investigated soils was surpassed the limited reported to be maximum tolerable level (5 μg/g).

The occurrence of Cd in the different chemical fractions followed this order: Residual > soluble + exchangeable > organically bound > Occluded on Fe, Al and Mn oxides. > specifically adsorbed, which means that Cd is more leachable and mobile than the other elements.

Concerning the concentration of Cd in plants grown on soils irrigated with sewage effluents for 60 years (profile 3), it was increased and tended to reach the toxic level. Plants grown on soils irrigated with industrial waste water contain high Cd concentration very close to levels of the toxicity range. However, those grown on the other locations contain high concentration of Cd located within the critical toxicity range (5-10 μg/g).

5-Nickel:

The content of Ni in soils ranges between 4.4 and 162 mg/kg soil, while DTPA-extractable Ni varied from 0.01 to 1.4 mg/kg.

The distribution of Ni among the fractions followed the order of: Residual > specifically adsorbed > occluded on crystalline Fe and Al oxides > organically bound > soluble + exchangeable > Occluded on amorphous Fe and Al oxides.

The threshold value (100 mg/kg) was exceeded by the total Ni in soils irrigated with industrial waste water (profiles 4,5) and in soils around smelters (profiles 12,13). Total Ni content in profiles (16 and 17) located on the east side of the road as well as in profiles 19 and 20 located on the waste side surpassed the thresold value.

The concentration of Ni in plants grown on the soils irrigated with sewage and industrial waste water was high, but still less than the level of toxicity. The Ni contents in plants grown on soils around the chemical factories or on soils adjacent to the highway are not harmful to animals.

6-Cobalt:

Total Co content in soils ranges from 19 to 59 mg/kg soil, and the DTPA-extractable Co varies from 0.16 to 1.43 mg/kg soil.

The distribution of Co among the fractions was followed this order: Residual > organically bound > Occluded on Fe and Al, oxides > specifically adsorbed > soluble + exchangeable.

Total Co content in soils was affected by sewage and industrial waste water, industry fallout and the motor vehicle exhaust fums.

Plants grown on soils irrigated with sewage effluents for 60 years contain high level of Co comparable to that of critical toxicity range. On the other hand, those grown on soils around chemical plants and smelters, or grown on soils adjacent to the highway contained less Co and their contents did not exceed that of the toxicity level.

The following remarks could be concluded:

1- Soils irrigated with sewage effluents are seriausly contaminated with Cu, Zn, Pb and Cd. Generally these heavy metals in addition to Ni and Co were increased with increasing the period of irrigation with sewage effluents and tended to decrease with soil profile depth.

2- The heavy metals were relatively high in soils around the chemical plants and smelters. Moreover, the content of Cu, Pb, Zn, Cd, Ni was high and exceeded the permissible level only in soils around smelters.

3- Soils adjacent to the highway contain relatively high concentrations of heavy metals which exceeded the permissible levels in some locations. Generally, the concentration of heavy metals decreased with increasing both of distance from the road and profile depth.