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5. SUMMARY

Environmental pollution and cultivated soil protection are considered two of the most serious problems that face mankind in the 21th century especially in the heavily industrial area of the world. A number of man's activities may lead to raising soil content of the heavy metals above the natural background. Heavy metals are difficult to remove from soils because they are strongly held on cation-exchange sites, their concentrations in soil solution are therefore low, and leaching is relatively ineffective for removing them from the soil.

Therefore, the objectives of this work were to study the following: (1) status of some heavy metals (Pb, Ni and Cr) in some soils of Qalubia Governorate, (2) treating the contaminated soils with four different materials: limestone (CaCO_3), CaO + coal 2 %, humic and citric acids to reduce available amounts of heavy metals (Pb, Ni and Cr) in these soils (chemical remediation) and (3) growing two plants (*Nerium oleander* and *Thevita nerifolia*) on the contaminated soils to reduce available amounts of heavy metals (Pb, Ni and Cr) in these soils (phytoremediation)

The experimental work involved a laboratory incubation experiment and a greenhouse one carried out at Soils, Water and Environment Research Institute (SWERI), Agricultural Research Center, Giza.

The incubation experiment was a factorial one in a complete randomized design with three replicates. Soil was daily weighted and watered to maintain moisture content in each

container at 70 % of the saturation percentage (SP). Soil sample from each treatment was taken after 1, 14, 28 and 42 days of the start of experiment and chemically analyzed for Pb, Ni and Cr.

In the greenhouse pot experiment, plastic pots were uniformly packed with 5-kg portions of air-dried soil (sieved through a 2 mm sieve). And cultivated with two plants i.e., *Nerium oleander* and *Thevelia nerifolia*. At harvest, the aerial parts were cut 1-cm above the soil surface, oven dried at 70 °C. Dry matter yields of roots, leaves and stems were measured and plant material was kept for chemical analysis.

The obtained results could be summarized in the following:

I. Status of Pb, Ni and Cr in some soils of Qalubia Governorate:

- 1- The highest values of Pb (total and DTPA-extractable) were found in El-Gabal El-Asfar farm soils whose total and available Pb contents exceeded by about 2.0 and 8.6 times, respectively; the corresponding values of El-Kanater El-Khayria soil (control). In Abu Zaabel Factory soils, total and available contents were about 1.5 and 2.1 times. The corresponding values of El-Kanater El-Khayria soil.
- 2- The highest values of both total and available Ni were found in Qalub soils (eastern side of the highway) whose total and available Ni contents exceeded by about 1.8 and 1.3 times; the corresponding values of El-Kanater El-Khayria soils. Also, El-Gabal El-Asfar farm soils contained higher values of available Ni exceeded by about 3.3 times; the corresponding values of El-Kanater El-Khayria soils.

- 3- The highest values of both total and available Cr were found in Abu Zaabel soils where they exceeded by about 7.0 and 5.1 times; the corresponding values of El-Kanater El-Khayria cultivated soils.

II. The incubation experiment (chemical remediation):

- 1- All the chemical materials used for remediating the polluted soils (i.e., limestone, calcium oxide + coal, humic and citric acids) could succeeded in reducing their available Pb, Ni and Cr contents.
- 2- Calcium oxide (CaO) + coal treatment was the most effective (and cheapest material) in reducing available Pb, Ni and Cr in the studied soils followed by the limestone (CaCO₃) treatment then humic acid treatment and finally the citric acid treatment.
- 3- The most suitable incubation period was after 28 days of incubation in all treatments.

III. The greenhouse experiment:

- 1- Pb, Ni and Cr concentrations and uptake by both *Nerium oleander* and *Thevita nerifolia* plants were far higher than the normal levels in the common plants. So, these plants can be used as hyperaccumulative plants for heavy metals in contaminated soils.
- 2- The comparison between the phytoremediation effects of the two tested plants, showed that *Nerium oleander* plants were more effective as hyperaccumulator for removal of extractable heavy metals in the following descending order Cr > Pb > Ni. *Thevita nerifolia* plants removed available amounts of these heavy metals in the descending order: Cr > Ni > Pb. The

- 3- The highest values of both total and available Cr were found in Abu Zaabel soils where they exceeded by about 7.0 and 5.1 times; the corresponding values of El-Kanater El-Khayria cultivated soils.

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superiority of *Nerium oleander* plants over *Thevita nerifolia* plants might be attributed to the higher absorbing area of roots of the former plants compared with the later ones.