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Chemistry of Nickel in Some Egyptian Soils

A thesis Presented by

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ABSTRACT

Due to the paucity of water resources in Egypt, many farmers are compelled to use low quality water in irrigation. So that the present study aims to investigate the Ni chemistry in soil continuously irrigated with sewage effluent water for long period.

Results of sewage effluent water revealed that water acidity (pH), salinity (EC), and concentration of (NH_4, Fe, Zn, and Cu) were within the permissible maximum limits cited by FAO (1976). Meanwhile; NO_3, Mn, and Ni concentrations were above PML. On the other hand in Nile water all the previous parameters were below PMLs.

The continual use of sewage water in irrigation improves soil nutrients status, but at the same time increases the possibility of nitrate as well as heavy metals contamination. Also, the physicochemical parameters of the waters were still appropriate for soil irrigation. The calculated SAR value was classified as slightly to moderate hazard however and it was still lower than the permissible maximum limit (PML). Meanwhile; NO_3, Mn, and Ni concentrations were above the PML.

Prolonged use of sewage water irrigation over 100-yerars led to detectable increases in all the tested soil parameters, except for $CaCO_3$ content. The soil was uncontaminated with Fe, contaminated with Cu, Mn, and Zn, and polluted with Ni. The values of Zn equivalent in sewage effluent irrigated soils were above the critical level.

In the sewaged soils the maximum concentration of Ni was in the surface and to some extent in subsurface, and then it decreased irregularly with depth. The total percentage recoveries of Ni proved that the used

procedure to fractionate Ni to its several pools is reliable and satisfactory. With increasing period of sewage effluent application the percentage of residual Ni fractions decreased and transformed to the other fractions, corollary to that possessing more threats to the environment. With the continued use of sewage effluent water Ni has high potentials to be mobile and consequently posing environmental hazards.

Amending Ni-contaminated soil either by activated charcoal (AC) or diammonium phosphate (DAP) led to increase of residual Ni on the expense of the other Ni fractions. Diammonium phosphate material was more effective than activated charcoal materials in immobilizing Ni in contaminated soil.

The continual uses of sewage effluent water in irrigation increased Ni^{2+} activity by 6.73 folds than that in unpolluted soil sample. After remediation The DAP material was more effective in decreasing Ni^{2+} activities than that of charcoal material.

The constructed stability Ni diagram indicated that the Ni solubility in sewage effluent–contaminated soil is controlled by $Ni_3(PO_4)_2$ mineral in equilibrium with Ca. phosphate (log CO_2=-2.52 atm.), while in uncontaminated soil, $NiFe_2O_4$ mineral in equilibrium with $Fe(OH)_3$ amorphous was likely governed Ni solubility.

Among the tested ecological assessment indices, Risk assessment code index (RAC) which based on soil fractionation studies provide useful information for assessing metal bioavailability or toxicity. RAC could be able to differentiate between degree of soil heavy metal contamination (uncontaminated, contaminated, and remediated soil).

Keywords: - sewage effluent, soil properties, Nickel chemistry, soil contamination, soil remediation, Ni activity, ecological risk, fractionation.