Improvement of soil charachterstics in some soils irrigated with low quality water

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This work aims to evaluate the effectiveness roles of some natural (i.e., organic compost, bentonite shale, CaCO3) and chemical (i.e., carboxy methyl cellulose and Fe-Mn oxides) soil amendments to remediation heavy metal contaminated soils, which are affected by using waters contaminated with sewage effluent and industrial wastes for irrigation, for alleviating their hazardous effects on plants grown. Thus, a study was executed on two soil sites at Abou-Rawash farm (western of Giza) and El-Tebeen (southern of Cairo) a reas, E gypt. T hese s oil s ites h aving d ifferent textural grades (i.e., sandy loam and clay loam) and irrigated with waters contaminated with sewage effluent and industrial wastes, respectively.The obtained results could be discussed and summarized under the following items:5.1. Chemical composition of the used irrigation waters:Results of the chemical composition of used irrigation water at the chosen two soil sites show, in general, pH value was 7.13 and 8.42 for the studied water sources at Abou-Rawash and El-Tebeen areas, respectively. The corresponding relatively low and high pH values are mainly due to the effect of the nature of suspended matter in each of the sewage effluent and industrial wastes.The ECiw values were 0.93 and 4.68 dS/m at Abou-Rawash and El-Tebeen areas, respectively, reflecting the effect of total soluble solids in both two water sources. According to the salinity classes of Ayers and Westcot (1985), these low quality waters are lying within the second (Abou-Rawash site) and third (El-Tebeen site) categories; denote an increase and severe problems, respectively. In general, the d minance of both soluble Na÷ and Cl-; denotes that NaC1 is e probable dominant salt in such low quality water category.The SAR values recoded 3.20 and 13.56 forithe both the contaminated waters with sewage effluent and industrial wastes, respectively. According to Ayers and WeStcot (1985), the first and second low quality water are laying within the first and third classes (< 6 and > 9.0), denoting no problems for the fist site and severe problems for the second one is expected for soil sodicity.Generally, there is a wide variation in the studied heavy metals values, i.e., Zn, Mn, Fe, Cu, Cd, Ni, Co and Pb in boththe applied two irrigation low quality waters. The recorded progressively increases for all the studied heavy metals at the El-Tebeen site are mainly due to its contamination with industrial wastes. According to their contents in both studied water resources, it could be categorized into: an ascending order of Zn > Fe > Pb > Mn > Cu > Ni > Co > Cd for Abou-Rawash site vs Fe > Mn > Pb > Cu > Zn > Ni > Co > Cd for El-Tebeen one. It is noteworthy that although the contents of the previous elements are relatively high in the sewage effluent at Abou-Rawash site, yet their levels are still laying within the safe range for irrigation water (FAO, 1992).whereas, those of El-Tebeen site (contaminated with industrial wastes) are lying outside the permissible limits, indicate that once these metals released into soil matrix, have potential impact on environment quality, human health and represent a g reat risk for safe b oth g round and surface w ater supplies (Kim et al, 1997).5.2. Degradation of soil properties as affected by using the low quality of irrigation water:Some of soil chemical properties were more negatively affected by the increase of soil salinity and sodicity due to the usage of low quality water in irrigation purpose. In general, it isnoticed that the usage of the studied low quality water for irrigation caused a pronounced increase in soil pH value (8.65) at El-Tebeen, while the reverse was true for Abou Rawash one that exhibited a relatively low pH value (7.30). Such a wide difference in soil pH is more related to the natur of chemical composition of the suspended matter and polluta is as well as the occurrence of active

organic acids and the elease CO2. which dissolves in water forming carbonic acid that lowers soil pH at Abou-Rawash site. Moreover, the usage of such low quality w ater a t E 1-Tebeen s ite resulted in a r elatively h igher soil ECe value (93.10 dSm-1). which is evidently by a proportionally increase of irrigation water salinity (ECiw = 4.68 dSm-1). Also, the dominance of soluble Na+ and Cl-indicates that NaC1 is the dominant salt, and such soil is unproductive sodic one.A pronounced decrease. in soil organic matter content (0.23 %) was occurred for soil irrigated with industrial wastes contaminated water at El-Tebeen site as compared to that irrigated with sewage effluent contaminated one at Abou-Rawash (3.52 %). This may probably due to depress the crop remained residues vs the accumulation of suspended organic colloids in soil at Abou-Rawash. It is quite noticeable that the ESP value exhibits a progressively increase in soil irrigateddirectly with water contaminated with industrial wastes at El-Tebeen site. This is mainly due to the relatively high sodicity of the used irrigation water, which stimulated more displacement of Ca and Mg by Na on soil colloidal complexes.The soil total and bioaVailable contents of the studied heavy metals exhibited relatively high values for soil subjected directly to water attained the greatest values of pollutants, i.e., industrial wastewater at El-Tebeen site. The magnitude of the relative increases for these heavy metals in the studied soils takes a nearly parallel trend of their contents in the applied irrigation water, as follows: Zn > Fe > Mn.> Cu > Pb > Ni > Co > Cd. According to the safe scale outlined by FAO (1992), the studied metal contents are outside the permissible ranges for soils of both Abou-Rawash and El-Tebeen sites.5.3. Fractionation of the tested metals in the studied soils:Heavy metals exist in the studied soils could be partitioned into five operationally defined fractions, i.e., exchangeable, carbonate bound, Fe-Mn oxides bound, organic matter (non-residual metal) and residual metal. The sum of various fractions of Zn, Mn, Fe, Cu, Cd, Ni, Co and Pb were about 85, 93, 81, 87, 95, 91, 89 and 83 % of their actual total contents, respectively, proving satisfactory of the appliedprocedure. As for Abou-Rawash site, the studied metals are bound to a greater or lesser extent to organic compounds, which derived as suspende& matter through the deposited sewage sludge, with an exception for each of Mn', Cd and Ni which are almost exclusively in residually complex forms followed by Fe & Mn bound to iron and manganese oxides. The second dominant form of the studied heavy metals was the residual fraction, may be due to the possibility of precipitation of soluble metals burden in sewage effluent and the slow diffusion of such metals into the interior lattice of soil minerals.Moreover, the results suggested that Fe & Mn oxides _might play an important role in Mn,. Fe. Cd and Pb immobilization. As for the carbonate fraction, results show that Cd followed by Co and Zn represented the prevailing ions on this form. The predominant portion of exchangeable fraction was, associated to Co followed by Cd and Zn. The magnitude of various fractions of the studied heavy metals for the contaminated soil site at El-Tebeen area show that the studied metals are bound to a greater or lesser extent to residually complex forms, except of Mn and Fe which are almost exclusively in Fe-Mn oxide forms. This is true since the studied soil has pronounced amounts of clay, CaCO3 and contaminated with industrial wastes.5.4. Effect of applied soil amendments on immobilization of the bioavailable heavy metals in soil:A large number of different amendments have been proposed and tested for in situ immobilization of heavy metals in the studies soils, i.e., organic compost, bentonite shale, CaCO3, carboxy methyl cellulose (C.M.C.), iron and manganese oxides, with incubation periods of one and two months under an almost constant soil moisture of 70 % of the water holding capacity.Whilst the application Qf soil amendments had a greater effect on reducing soil bioavailability of the studied heavy metals in both the two treated soils at A bou-Rawash and El-Tebeen sites. The bioavailable metal contents showed a tendency to decrease by increasing the applied amendment rates, with a rather greater response for CaCO3 and organic compost, particularly at the applied highest rates, at the soil sites of Abou-Rawash and El-Tebeen, respectively. These results suggesting that the combined effect CaCO3 and organic compost have directly greater potential to immobilize the heavy metals.It could be explained on the basis of metal adsorption onto CaCO3 is facilitated through the exchange of Ca2+ from itsparticles with the metal cations in soil solution. These fairly stable-carbonate compounds have extremely low solubility over a wide pH range. In addition, the dissolved organic carbon compounds have been shown to decease the sorption of heavy metals onto soil surface by competing for free metals and forming organo-complexes or being preferentially sorbed onto surface

instead of the metals for which they are competing.The Fe-Mn oxides, C.M.C. and bentonite shale occupied and second, third and fourth categories from the point of immobilized view, may be due to there is an evidence that specific sorption of metals by these inorganic and organic materials is more stable. It could be arranged the applied soil amendments according to their effectiveness roles for immobilizing the studied metal into: CaCO3 > Fe-Mn oxides > compost > C.M.C. > bentonite at the soil site of Abou-Rawash vs organic compost > C.M.C. > Fe-Mn oxides > CaCO3 > bentonite at the soil site of El-Tebeen.5.5. Plant growth and metals uptake as affected by heavy metals immobilization:The b eneficial effects of the s tudied amendments w ere positively reflected on increasing maize plants ability for water and nutrients, consequently increased the vegetative growthparameters, i. e., plant height and dry matter weights of maize shoots.Moreover, the effectiveness of the applied soil amendments on the studied plant parameters differed according to their immobilizing roles of soil heavy metal contents, however, the treatments of CaCO3 and organic compost surpassed the other tested one5, for increasing maize vegetative growth in Abou-Rawash and El-Tebeen sites, respectively. This was true, since beneficial effects of the applied two amendments and their rates show a parallel trend for the studied plant parameters, due to their residual effects on reducing the extractability of Zn, Mn, Fe, Cu, Cd, Ni, Co and Pb were more visible.The heavy metals response of Zn, Mn, Fe, Cu, Cd, Ni, Co and Pb to uptake and accumulate in shoot tissues of maize showed a closely relationship to their corresponding reduction in the bioavailable contents in the experimental soil treatments as a result of applying the tested soil amendments. That is true, since the application of applied soil amendments led to convert significant amounts of the studied heavy metals from non-residual forms to residual one, with more effective for both CaCO3 and compost in transforming these metals. Moreover,the released Ca2+ through CaCO3, under the presence of CO2, competes with those metals for pant uptake. In addition, the released Ca2+ causes an inhibition of the translocation of such metals from roots to shoots.5.6. Effect of applied amendments on fractionation and mobility index of the studied heavy metals:Results show that the studied heavy metal fractions tendency to increase towards the residual fraction, however, the addition of the tested soil amendments substantially increased its values for the studied heavy metals in soils. Such findings are emphasized by the corresponded metal concentrations in shoot tissues of tested maize plants, this is true since the percentages of the residual fractions for all the studied nutritive and non-nutritive heavy metals reached the greatest percentages under the soil amendments under study.Also, the organic fraction was the next most important form where its corresponding percentages amounted pronounced values, followed by Fe-Mn oxides, carbonate and exchangeable forms. In general, it could be categorized the different fractions of the studied metals in an ascending order: residual > organic > Fe-Mn oxides > carbonate > exchangeable for both the studied soil sites of Abou-Rawashand El-Tebbeen, with a more pronounced values for metals bound to Fe-Mn fraction at the later site.Moreover, the obtained values of the mobility index of heavy metals at experimental phases, i.e., maize plants grown on soils of Abou-Rawash and El-Tebeen sites, indicate that the values of mobility index show tendency to decrease with increasing the effectiveness role of the applied soil amendment for immobilizing the bioavailable contents of the studied metals. however, they could be arranged in an ascending order: CaCO: > Fe-Mn oxides > compost > C.M.C. > bentonite at Abou-Rawash site vs compost > C.M.C. > Fe-Mn oxides > CaCO; > bentonite at El-Tebeen site.from the technical view, chemical immobilization of heavy metals using natural agents such as lime and compost is an technique method o f reducing heavy metals solubility and mobility on a short or long-term of use as well as it is not expensive due to the relative low cost of production. This is due to lime and organic compost are found as natural shale in large quantities at some desert locations at Egypt and as crop residues or industrial agriculture byproducts, respectively.