Effect of seage sludge amendments soil on accumulation of some heavy metals in plant

Samir El-sayed Mahrous

Land application of sewage sludge has been practiced locally in many areas for its effect on soils and crops.The objective of this study was to investigate the effect of applying sewage sludge to soil and plants grown on the amended soil. Two pot experiments were carried out during two successive seasons (96/97 and 97/98) in the green house using two soils (clay and sand), and using rates of 25,50, and 75g/kg dried sewage sludge (ss); two extra treatments were done, one with mineral NPK fertilizer and the other without addition of ss or NPK.The first season consisted of fababeans, and barley. The second one was carried out to investigate the residual effect of added sewage sludge . Sudan grass succeeded the fababean crop (of season 1), and soybean succeeded the barley crop (of season 1).Plants of second season were grown on the same pots of the first season after harvesting crops of season 1. Only pots of NPK treatment were supplied with NPK in the second season, (i.e. chemical NPK was included in each season).Results of the two seasons are summarized as follows: I. Effect on soil chemical properties:Application of sewage sludge increased soil salinity in both two tested soils, and has a slight effect on decreasing soil reaction. Moreover, increased the availability of some macro elements.Available micro nutrients (Fe, Mn, Cu, Zn and B) were increased by addition of sewage sludge; also heavy metals (CdPb, Co, Ni and Cr) increased with sludge application, however, the concentrations of these elements did not reach toxic levels after the two growing seasons.Evaluation of the availability of the elements: Availability index (AI):There was a gradual increase in AI with increasing the rate of sludge application , in the initial and final soil samples, however, the sandy soils attained higher values than the clay one. For the highest rate of sludge, the AI showed a pattern of:Pb> Zn> Cu> Mn> Ni> Cd> Fe> B > Cr in the clay soil ; and Zn> Cu> Pb> Cd> Ni> Co> B> Mn> Cr> Fe for the sand soil. Zinc equivalent :According to Zn equivalent, it was found that, the maximum rate of dried sludge to be added to the soils is 150g/kg which is equivalent to 150 ton/fed. before the safe limit is exceeded,.In this respect, the metal equivalent value was proposed due to toxic effect of Cd. where the highest rate of sludge (75g/kg) indicate 17mg/kg which is very much lower than the critical value of (600 mg/kg).II. Influence of sewage sludge on plant (dry matter, yield and chemical constituents).• Barley:The application of sewage sludge leads to significant increase in dry matter of barley and its grain yield. Barley grain yield can be predicted by the analysis of soil before planting, throughout multiple regression analysis.Application of sewage sludge significantly increased theconcentration of macro and micronutrients (N, P ,K , Fe, Mn, Cu, Zn, and B) .The same trend occurred with heavy metals (Cd, Pb, Co,Ni, and Cr)although their concentration in grains did not reach to toxic levels.Faba bean:A significant increase in the plant dry matter and yield occured with sludge addition. Moreover, the yield can bepredicted by the analysis of the soil before plantingthroughout multiple regression analysis.It is noticed that Clay soil gained a significant effect on N,P and K content than sandy one .Fe concentration increased by the application of sludge up to 50g/kg. Clay soil has the superiority of Fe and Cu than sandy soil except in the flowering stage. Mn concentration increased by increasing rate of sludge to become significant atthe highest rate at harvest time, the shoot contains 4 times of Mn than seeds.Boron concentration is reduced to reach the lowest values in straw where, it translocated to seeds.Accumulation of Cd in plants relatively increased as the plant progressed in age . However at harvest time , shoot contains higher amount of Cd than seeds. Moreover, faba

bean grown in soils polluted with Pb show a relatively large Pb enrichment in both vegetative and generative organs (seeds) but fortunately the level of Pb is less than toxic levels.-217-Lead and Cobalt concentration as well as Ni and Cr increased with sludge application but still below critical limits.Biological and ecological assessment of the elements:A.Concentration Index (CI):It is evident that CI values in barley of different elements are variable which indicate that the same plant species can accumulate elements from the same substrate with different magnitude . CI values increased with increasing sludge application particularly, in the sandy soil .The same trend is observed by fababean plant where the ability to adsorb metals decreased in this order: Clay soil > sandy soil.B.Transfer coefficient (TC):TC values in barley grains is as follows :B> Cr> Co> Cd> Ni> Zn> Pb> Fe> Mn=Cu in clay soil andCr> Co> B> Cd> Mn> Zn> Fe> Cu> Ni> Pb in sand soil . For fababean seeds the pattern is:B> Cr> Co> Zn = Pb> Cu> Mn> Fe in clay soil, and : Co> B> Cr> Cd> Ni> Mn = Cu> Pb> Zn> Fe in the sand soil. However, there is a slight reduction in TC of Fe, Mn, Cu, Zn, Cd, Pb, and Co in faba bean seeds in both soils due to increased rate of sludge application.C.Tolerance Index (TI):The TI values indicated a gradual increase in faba bean and barley shoots by increasing sludge application, this means that sewage sludge has a vafourable effects on plants. It is noticed that TI values were greater in barley than beans.Influence of sewage sludge residue on plant :•Soy beans following barley:Dry matter content is increased by increasing rate of sludge application up to 75g/kg soil.Sandy soil exhibit an increase in yield reaching about 1.3 fold that of the control at the highest rate of sludge application. Sludge residue induced an increase in N, P, and K in soy beanshoots and seeds. Also Fe, Mn, Cu, and Zn concentration in soy bean increased. The concentration of this metals was higher in straw than seeds. There is no differences between variousfertilizer residue, concerning their effect on B concentration in soy bean plant.Concentration of Cadmium , Lead , Cobalt and Chromium were increased particularly during flowering and harvest but remained within the normal range for most plants.Concentration of Ni in seeds receiving highest rate of sludge , increased by 100%; this also occurred with th lowest rate concerning Cd , Pb, Co, and Ni concentration in plant.•Sudan grass following fababeans:There is a significant increase in the dry matter accumulation with increasing the level of sludge application. However, drymatter yield in the three cutting was progressively decreased with subsequent cuttings.N, P, and K concentration slightly increased with increasing the sludge residue, however, plants grown in sandy soil sufferedfrom N deficiency except those growing at the higher rate of sludge residue.Generally sewage sludge residue especially at the rate of 50 and 75 g/kg supply plants with high concentration of N, P,and K.Sludge residue induce a remarkable increase in Fe, Mn, Cu, Zn and B concentration by plants which becomes pronounced at higher sludge application rate. However, for all fertilization treatments , there is a gradual decreased in micronutrient concentration with a successive cuttings.The pattern of magnitude was: Fe> Zn> Mn> Cu in both two soils, whatever the fertilization treatments.Heavy metals of Cd, Pb, Co, and Ni increased in plant by sludge application in the two soil types, but Cd and Co showed little change and Ni concentration slightly decreased. Cr showed no change in the successive cuttings in both soils.It can be concluded that, the levels of the studied heavy metals in the previous crops are within the permissible limits and below the concentration that have toxic effects on plant growth or human health.It is worth to mention that, since seeds and grains have a low content of heavy metals, therefore, heavy metals pollution problems can be alleviated by selecting crops with a low rate of uptake or non-edible crops.