Modification of Cu, Zn, Fe and Mn levels in soils and effect on *Lolium perenne* L. var. cuartet (ryegrass) production in degraded soils amended with successive applications of sewage sludge

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The use of sewage sludge in agricultural or degraded soil is gaining popularity as a means of waste disposal. Sewage sludge generally contains high organic matter content, microorganisms, macronutrients (phosphorus, nitrogen and potassium), microelements (Zn, Cu and Fe), and inorganic substances such as silt, clay and calcium carbonate. Therefore, represent an organic waste with high potential to provide soil benefit and enhance their productivity [1-2]. However, the presence of high level of metals in the sludge could represent an environment risk caused by leaching, erosion, or runoff losses to ground or superficial water [3]. We hypothesized that the successive application of sludge to degraded soil will increase the nutrient availability for the plants, thus increasing the productivity of soil. On the other hand, the best accumulation of these nutrients by crops could avoid losses through the soil profile. Considering the important to gain knowledge about the long-term effects of sewage sludge application on soil and crops, the objectives of this study was to evaluate the modification of Cu, Zn, Fe and Mn levels in soils and effect on *Lolium perenne* L. var. cuartet (ryegrass) production in degraded soils amended with successive applications of sewage sludge. The soils used in the study were two, an Andisol belonging to Gorbea serie and an Ultisol belonging to Collipulli serie. Both soils are characterized by present condition of degraded soils. The amendment was a stabilized sewage sludge obtained from an aerated pond used for the treatment of bleached kraft mill wastewater and was collected from a landfill after one year disposal. The sludge was applied in the soils at rates of 0, 10, 20 and 30 t ha^{-1}. The soil-sludge mixture was put on 1 kg pots and was sowed with ryegrass; the pots were incubated at 20°C during a year. The sludge addition in the soils was repeated every three months. The concentrations of Cu, Fe, Mn and Zn were determined in the soils after three months of sludge application. On the other hand, in a separate study, dry biomass and Cu, Fe, Mn and Zn contents in the foliage of *Lolium perenne* L. var. cuartet (ryegrass) was determined in samples collected after three months of sludge application. The results showed that microelements Mn and Zn were the most affected by sludge application in the soils. After four sludge additions, Gorbea soil showed an increase of 2.4 to 6.3 times in Mn contents and between 10 to 40 times in Zn contents when increasing rates of sludge was applied. Whereas, Collipulli soil showed an increase of 3.3 to 5.6 times in Mn contents and 9.5 to 20 times in Zn contents. The dry biomass analysis for the first mow of ryegrass showed an increase in the in Collipulli soil amended until with 20 t ha^{-1} of sludge, while dry biomass of ryegrass in Gorbea soil was decreased with the two higher rates of sludge. A significant accumulation of Mn and Zn in foliage of ryegrass was observed with the sludge application in higher rates (20 and 30 t ha^{-1}). In conclusion, the sewage sludge application causes an accumulative effect in concentration of Zn and Mn in the soils. This accumulation was reflected in the levels of Mn and Zn in the foliage of ryegrass. Futures studies in field condition with realistic environmental condition are necessary to verify these preliminary results and moreover the nutrients leaching potential.

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