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Barium in an Oxisol treated for nine consecutive years with sewage sludge and cropped with maize

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As consequence of the new technologies and the increase in the world population in the last 10 years, there was intensification in the industrial and agricultural activities and also in the mining and urbanization, causing a great increase in the production of pollutants in the environment and mainly in the soil. Sewage sludge, the waste that results from the treatment of the wastewater, can be used in the agriculture as source of plant nutrients. However, sewage sludge may also contain elements potentially toxic called heavy metals, which normally accumulate in the soil profile when the waste is continually applied. The objective of this work was to evaluate how the heavy metal barium (Ba) is distributed in the different fractions (soluble, exchangeable, linked to organic matter, amorphous and crystalline iron and manganese oxides, and residual) of a soil that was treated with sewage sludge for nine consecutive years by using the sequential extraction method. The experiment started in the summer of 1997 and was carried out in Jaboticabal, SP, Brazil in a soil classified as Typic Eutrorthox. The experimental design was randomized blocks with four treatment (rates of sewage sludge) and five replications. In the first year the treatments were T0= control (no sewage sludge and no chemical fertilization), T1= 2.5 t ha^{-1} sewage sludge, T2= 5.0 t ha^{-1} sewage sludge and T3= 10.0 t ha^{-1} sewage sludge (dry basis). From the second year, the control plots received NPK mineral fertilization based on soil chemical analysis and the indications of Raij et al. (1997) and the plots of the other treatments received NPK fertilizer in a rate that, summed to the NPK contained in the sewage sludge, resulted in the same rates applied to the control. From the fourth year the rate 2.5 t ha^{-1} was replaced by 20.0 t ha^{-1} in order to try promoting plant toxicity, so that the accumulated rates of sewage sludge in the eighth year of experimentation were 0, 40,

80 and 107.5 t ha^{-1}. In the first growing year of experimentation (1997/98), the soil was ploughed and harrowed and then 2.5 t ha^{-1} dolomitic limestone were applied to raise the base saturation to 70% Thirty days after liming, the plots were marked out (6 x 10 m), sewage sludge eas spread on soil surface and incorporated into the top 10 cm layer with a rotary hoe. Maize was then cropped. This same methodology was adopted for next five years, only changing the rotary hoe by a light harrowing. In the seventh year the test plant was sunflower. In the eighth year the test plant was *Crotalaira juncea* L. and in the nineth year the plant was maize again. After sewage sludge incorporation, the furrows were open (0.90 m between lines), the mineral fertilizer was applied into the furrows (280 g simple superphosphate per plot, 80 g KCl per plot and 150 g $(NH_4)_2SO_4)$ per plot for the control and the sowing proceeded (7 - 9 seeds by meter). Soil samples (0-0.20 m) were collected 60 days after sowing; 12 single samples in the useful area of each plot (6 on the sowing furrow and 6 between sowing lines), which were jointed, mixed, air dried, sieved (2 mm) and submitted to a sequential extraction method (Revoredo, 2003, André, 2003). The data were submitted to the variance analysis and if the F test was significant, the Turkey's test at 5% were applied for means comparison. The Ba distribution in the soil fractions occurred in the following sequence: soluble + exchangeable $>$ manganese oxide $>$ amorphous iron oxide $>$ organic matter $>$ residual $>$ crystalline iron oxide. Ba in the fractions soluble+exchangeable and manganese oxide, organic matter and residual are not different by the Turkey's test at 5%. The fractions amorphous iron oxide and crystalline iron oxide are different and also differed form the other fractions. The percentual distribution of Ba in the different soil fractions were: soluble+exchangeable= 29,76%, manganese oxide= 28,54%, amorphous iron oxide= 20,70%, organic matter= 10,25%, residual fraction= 8,61% and crystalline iron oxide= 2,14. The content of Ba in each soil fraction was not affected by the rates of applied sewage sludge.

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