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Agricultural and ecological aspects of soil fertility improvement by application of composts produced from municipal solid wastes

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One of the most interesting options for municipal solid waste management is production of composts, which application to the soil could resolve two great problems: storage of municipal solid wastes and nutrient recycling in food chain. However, due to high concentration of heavy metals in some wastes, application of these composts may cause environmental problems and hazard.

This paper presents results of plot experiment, where two different composts produced from municipal solid wastes were applied to sandy soil. Both composts were produced in different regions, one originated from industrial area contained high concentrations of some heavy metals. Composts were used non-recurrently in rates of 18, 36, and 72 t/ha, calculated as dry matter. Plots without fertilization, as well as those fertilized every year with mineral forms of NPK, were used as control. Triticale (X Triticosecale), cultivated in a 3-year monoculture, was used as the experiment plant. Soil samples were collected one month after application of composts, as well as each year after harvesting.

Obtained results indicated that application of both composts caused an improvement in physical properties, connected mainly with increasing content of organic matter. However, statistically significant increases of total porosity were found only in short time after composts application, and only in soil amended with the highest dose. Similarly, an addition of composts affected the field water capacity and retention of plant-available water, which is held in soil by forces of pF $>$ 3.0. Mineralization of organic matter over time diminished the positive effects of compost amendment, such that in the second and the third year of the trial no effects were observed.

Despite of soil carbon content decreasing with time, in the third year after the compost application the C:N ratio clearly increased, which was connected with exhausting of nitrogen reserve.

Application of both composts caused strong increase of available nutrients P, K, and Mg, which was observed during the entire period of the experiment. Beneficial changes were also observed in soil humic substances composition, connected mainly with increasing of humic acids and humic/fulvic acid ratio. Amendments contributed to improvement of soil sorption properties, through increasing cation exchange capacity and base saturation. Due to rapid decomposition of organic matter, that effect was in the second year of experiment much poorer, and in the third year it was observed only in the plots with highest doses of composts.

Compost originated from industrial area, even if applied in the low doses, caused the increase in soil concentrations of heavy metals, in particular of Zn, Pb, and Cu. This fact did not result, however, in any substantial changes in the degrees of soil contamination with heavy metals. Despite increasing the total contents of heavy metals in soils fertilized with composts, concentrations of heavy metals in Triticale grains and straw did not increase. This was connected with low content of easy soluble forms of metals in composts. Furthermore, in the first year of experiment, plant uptake of Pb, Cu and Zn was partly inhibited in the plots fertilized with both composts. This was probably connected with increasing of organic matter and organo-mineral complexes.

The yields of straw and grains depended significantly on fertilization with composts. The highest Triticale yields, as well as the highest nitrogen content in straw and grains, were obtained in the first year from the plots fertilized with the highest dose of compost from Zywiec, and the effects were comparable to those obtained with fertilization with mineral NPK. Beneficial effect of compost application tended to decrease during the experiment, so that in the third year no significant effects of composts were observed. Low availability of nitrogen was found to be the most important factor to limit the aftereffects of composts, what was indicated by the low content of nitrogen in Triticale grains.

The experiment indicated that an application of composts improves fertility of sandy soils, while extent and stability of changes depends on the amount and quality of organic matter applied with the compost.