



Long term effects of pharmaceutical sludge application on soil properties: a 17 years long case of study

Mirko Cucina (1), Chiara Tacconi (1), Daniela Pezzolla (1), Simone Sordi (3), Claudia Zadra (2), and Giovanni Gigliotti (1)

(1) Department of Civil and Environmental Engineering, University of Perugia, Perugia, Italy (dpezzolla@hotmail.com), (2) Department of Pharmaceutical Sciences, University of Perugia, Perugia, Italy (claudia.zadra@unipg.it), (3) ACS Dobfar SpA, Tribiano (Milan), Italy, (simone.sordi@acsdobfar.it)

Although European and national laws encourage the recovery of organic matter and plant nutrients through the agricultural reuse of sludge as amendment, the long-term effects of pharmaceutical sewage sludge application on soil properties is still unknown. The aim of the present work was to evaluate the long-term effects on soil properties of a 17 years long application of a pharmaceutical sewage sludge (PSS) derived from the daptomycin production wastewater treatment. To achieve the aim, physico-chemical properties, heavy metals concentrations and biochemical functioning were investigated in unamended and amended soils.

Physico-chemical fertility was improved through the application of pharmaceutical sewage sludge (e.g. humified organic matter, cation exchange capacity and plant macronutrients were increased proportionally with the sludge application doses). Soil biochemical functioning was slightly improved by the application of low PSS doses, measured in terms of microbial biomass and soil hydrolytic activity (FDA hydrolysis). Conversely, the highest PSS application doses ($> 50 \text{ Mg ha}^{-1}$) caused a significant increase of Zn and Cu (both in the total and bioavailable forms), which were significantly correlated to toxicity trends showed by the decrease of the dehydrogenase, urease and phosphatase activities.

According to the results, the application of PSS at the dose of $2.5 \text{ Mg ha}^{-1} \text{ year}^{-1}$ resulted in the enhancement of soil fertility and the minimization of environmental risks.