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Editorial

Biosolids Soil Application: Agronomic and Environmental Implications 2013

Silvana I. Torri,[1] Rodrigo Studart Corrêa,[2] Giancarlo Renella,[3] Leonid Perelomov,[4] and Alejandro Valdecantos[5]

[1] *Cátedra de Química General e Inorgánica, Departamento de Recursos Naturales y Ambiente, Facultad de Agronomía, Universidad de Buenos Aires, San Martin Avenue 4453, 1417 DSE Buenos Aires, Argentina*
[2] *Department of Ecology, Catholic University of Brasilia, CP 04401, 70910900 Brasilia, DF, Brazil*
[3] *Department of Agrifood Production and Environmental Sciences, University of Florence, Piazzale delle Cascine, 28 50144 Florence, Italy*
[4] *Department of Biology and Medicine, Tula State University, Lenin Avenue 92, Tula 300600, Russia*
[5] *Centro de Estudios Ambientales del Mediterráneo (CEAM), C/Charles R. Darwin 14, Parque Tecnológico, 46980 Paterna, Spain*

Correspondence should be addressed to Silvana I. Torri; torri@agro.uba.ar

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World production of biosolids is ever increasing due to global population rise and social progress, particularly in emerging countries. While technologies to reduce, transform, or reuse biosolids are under continuous development, their safe use in agriculture is still considered the main feasible option. Land application of biosolids can significantly reduce sludge disposal costs and provide varying amounts of nitrogen and phosphorus to crops. The use of biosolids as a source of organic matter improves the physical and chemical properties of agricultural soils, resulting in an increase in crop yields. An explanation to this is that, by its nature, agriculture has a negative balance in terms of organic matter and soil nutrients content which leads, on the term, to soil physical degradation and reduced chemical and biochemical fertility.

Agriculture use of biosolids still has a large consensus, being both a cost effective practice and a way to close the nutrient loop in agriculture and remediated degraded soils. The consensus is even increasing in the sight of the possible advantages of biosolids soil incorporation as a feasible way to balance anthropogenic greenhouse emissions. However, the complexity of both biosolids and soil systems, the rapid and large impact on the biogeochemical cycles, and the scale of agriculture still pose risks and uncertainties to predict their effects on the long term and global change scenario. This special issue aims to fill the current gaps in the knowledge of this specific field, although more research is surely needed in a near future.

An aspect gaining worldwide attention is biosolids management in terms of global C budget. Many experiments indicate that application of biosolids to land or opencast mines resulted in an increase in carbon reserves of soils from different regions and under different management practices. The potential of the main mechanisms controlling C sequestration in soils amended with biosolids was discussed in the review article by S. Torri et al. The paper represents a revision of the latest knowledge on this topic, highlighting the role of the quality of the organic C (both from the soil and from the biosolids), soil biological components, soil properties, and the particular case of opencast mine sites.

C. Wallace et al. simulated rainfall conditions on mixed (cool and native warm season) grasslands on sloping, rocky soils to estimate nutrient and bacteria levels in runoff from biosolids and mineral fertilizer. The ability of narrow vegetated filter strips to reduce losses was evaluated. No significant differences were detected among mean fecal coliform levels despite large differences in magnitude. Losses of ammonia

and phosphorous were greater for biosolids application at the lower rate with no vegetated filter strips (LBU) than biosolids applied to the upslope half of the plot with the downslope half serving as a vegetated filter strip (LBF). Results of this study suggest that even a small vegetated filter strip can potentially reduce nutrient levels in runoff.

P. Jurado-Guerra et al. contribute to this special issue with an interesting study dealing with the length of the effects of increasing rates of biosolid applications on forage production in semiarid grasslands. Although the positive effect on grass productivity decreases with time, five years after single applications of biosolids, the amended plots still produce larger amounts of forage than the unamended ones. However, these authors also address some constraints that hinder the generalization of this practice in grasslands.

The paper titled "*Establishment of native grasses with biosolids on abandoned croplands in Chihuahua Mexico*" by Jurado-Guerra et al. illustrates how an appropriate use and land application of biosolids may help the establishment of forage production on degraded grassland soils. Their results showed that the use of biosolids apparently affected the growth parameters and yields of green sprangletop and blue grama crops, with the greater plant morphological modifications and crop yield increases observed for the green sprangletop. Authors concluded that biosolids application at 10 and 20 $\mathrm{Mg\,ha^{-1}}$ rates had positive effects on the establishment and forage production of native grasses.

M. Chorom et al. assessed a monometal and competitive adsorption of Cd, Ni and Zn in soils incubated with different contents of decayed cow manure. Most sorption isotherms were well described by the Freundlich equation and the monometal and competitive adsorption isotherms of Zn, Cd and Ni followed the L-curve type. Results showed that the mono- and multimetal sorption amounts increased with an increase in organic amendment content. This increasing was consistent with the CEC and particularly pH for the three soils. The metal binding sites in the organic matter were more selective for Zn and Ni than Cd. Competition significantly reduced metal potential mobility, especially for Cd and Ni.

In the paper titled "*Characterisation of organomineral fertilisers derived from nutrient-enriched biosolids granules*" by D. L. Antille et al., the authors compared two biosolids-based organomineral fertilizers, urea and raw biosolids application in grassland and arable crops. Results showed that OMFs were twice as efficient as biosolids and 5–10% less efficient than urea to produce ryegrass (*Lolium perenne* L.). OMFs optimum application rates remained within 10% difference compared to urea and consistently lower than biosolids. Differently to the biosolids, the application of OMFs at rates which do not exceed the optimum N rate for the grass crop has not induced significant changes in soil P Index. Therefore, the wastewater industry may convert sludge into balanced fertilizers with a better economic strength and safer environmental perspectives with regard to the cost of field spreading and N and P load on the environment.

In the paper titled "*Field-scale evaluation of biosolids-derived organomineral fertilisers applied to ryegrass (Lolium Perenne L.)* in England" by D. L. Antille et al., the authors studied organomineral fertilizers derived from nutrient-enriched biosolids granules. The fertilizers were produced by coating biosolids granules with urea and potash. Routine fertilizer analyses were conducted on four batches of organomineral fertilizers and biosolids granules and compared with a sample of urea to determine key physical and chemical properties of the materials which affect handling and spreading, soil behavior, and fertiliser value. The research utilizes a novel technology to improve the fertilizer value of biosolids, reduce disposal costs and deliver a range of environmental benefits associated with recycling.

B-J Koo et al. have set an experiment to evaluate how organic acids in root exudates affect the absorption of biosolid-borne metals by plants. Results showed that the concentrations of metals in the plant tissue grown on biosolids-treated medium were always higher than that from the standard medium, irrespective of species and cultivar. The amount of metal transferred from the biosolids-treated medium to the plant varied with the metal element, following the order: Cd > Ni = Zn > Cu > Pb > Cr. Interspecies and cultivar differences in metal uptake were trivial compared to differences induced by the treatment. Metal uptake decreased with the growth period and the kinetics of metal uptake and essentially followed a first order during the initial four weeks of growth, especially Cd and Zn.

The study of M. L. Silveira and G. A. O'Connor was designed to evaluate the effects of temperature on the potential leachable P pool and distribution of chemical P forms in a biosolids-amended soil. A P-deficient Spodosol was incubated with biosolids and inorganic P fertilizer at different temperatures. Cumulative P mass leached during the 90-d study for any P-source was low, but greater cumulative P mass was released from the biological P removal and composted biosolids than from the heat-dried materials. Increasing temperature (20 to 32°C) generally decreased cumulative P mass leached, suggesting greater soil affinity to retain P at higher temperature. In a static incubation experiment (no leaching), soil water-extractable P concentrations were reduced over time, but no temperature effect was observed. P distribution among the various fractions was not affected by temperature. The relatively great ability of the soil to sorb P masked differences in biosolids properties and the potential impacts of temperature on P lability.

The potentials of use of biosolids in a specific agricultural field such as the plant nursery were evaluated by B. De Lucia et al. This article sheds light on the specific agricultural activity of plant nursery for ornamental plant which produces high income for farmers of various productive districts in Europe and other World areas but relies on the use of peat and other no renewable substances for the preparation of the plant growth substrates and is one of the agricultural practices with the higher environmental impacts. In fact, the annual amount of peat used every year in the European Union for the production of ornamental plants and horticulture is in the order of 29 million m^3, with a high impact on peatlands' stability. It is estimated that field cultivation of ornamental plants may cause annual soil loss in the order of millions of cubic meters (m^3). The authors reported how the use of

compost from municipal sewage sludge in the plant growth substrates reduced the overall environmental impact of the plant nursery chain and did not affect the plant quality.

We hope that you find the special issue interesting and useful and that it will act as a precursor for more studies to come in the agronomic and environmental implications of biosolids soil application.

Silvana I. Torri
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Leonid Perelomov
Alejandro Valdecantos