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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Beneficiation of wastewater sludge

Quantifying the fertiliser value of wastewater sludge

A recently completed study by the Water Research Commission (WRC) developed a user-friendly wastewater sludge application rate advisor computer model.

Background

Beneficial use of treated municipal sludge in agricultural lands is a well-known practice around the world. This is because of sludge's soil conditioning effect and as a source of low-grade fertiliser.

Municipal sludge consist of appreciable amounts of macro and micro nutrients though not all the nutrients are immediately available for consumption by crops. The availability of the macro nutrients, nitrate (N) and phosphate (P) from sludge amended soils for consumption by plants (i.e. fertiliser value) is a function of sludge composition, climate and soil.

The current South African sludge guideline recommends sludge to be applied according to crop requirement with a maximum rate set at 10 Mg/ha/year. The guideline, however, does not provide detailed instructions on sludge recommendation rates taking into account the fertiliser value of sludge, crop nutrient requirement, and potential long-term heavy metal accumulation.

Objectives of the study

The overarching aim of this study was to develop a user-friendly sludge application rate advisor computer model that takes into account both the fertiliser value of sludge and crop nutrient requirements. The specific objectives were to:

- Test existing analytical methods for rapid characterisation of sludge N and P pools
- Investigate N release from sludge (fertiliser value) across South African agro-ecological zones and soil textural classes
- Investigate the fate and dynamics of trace metals in sludge amended soils.

Regarding the first objective, combinations of laboratory incubation and fractionation experiments were conducted to characterise sludge N and P pools. The second objective was mainly achieved by computer model simulations across five South African agro-ecological zones and four major soil textures. The third objective was achieved from field experiments conducted at East Rand Water Care Company (ERWAT).

Main findings

Characterisation of sludge N and P pools

Liquid sludge depth in drying beds as well as drying duration seems to influence the N and C content, organic matter constituents, as well as the N mineralisation rate (fertiliser value) of sludge. Liquid sludge dried in thick depths for longer duration appears to decrease sludge N and C content, while enhancing the lignified fraction of the sludge organic matter.

In contrast, sludges dried in thin layers within a short period were characterised by higher C and N contents, lower lignin composition as well as higher N mineralisation (fertiliser value). It was apparent that a large fraction of the organic matter in all sludges investigated was soluble compounds, which contributed to about 90% of the total N mineralised.

N release across South African agro-ecological zones and soil textures

Computer model simulations indicated that annual N release varied significantly ($P<0.05$) across agro-ecological zones

ranging from 25% in arid agro-ecological zones to 42% in super-humid zones. Similarly, annual N mineralisation rates varied significantly between sites within an agro-ecological zone and between soil textures within a site.

Therefore, from an agronomic and environmental perspective it is advisable to have site- and soil-specific annual N release rate.

Fate and dynamics of trace metals from sludge amended soils

There was a direct relationship between trace metal uptake by maize and sludge application rate. In most cases, trace metal concentration in maize plant tissue remained well below phytotoxic levels.

Nonetheless, seven consecutive years of sludge application at 16 Mg/ha/year under dryland maize farming increased canopy Zn concentration to phytotoxic levels. This is in contrast to the soil Zn concentration which remained far below the environmental threshold levels.

A large fraction of the trace metals in the soil profile of all sludge treatments was EDT extractable. While the water soluble fraction of Cd and Pb remained below detection limit (<1 mg/kg) while Zn and Pb accounted for less than 1% of the EDTA extractable fraction.

Therefore it is of great importance to develop an integrated sludge management practice which comprises monitoring of the soil profile for potential heavy metal accumulation and monitoring crop canopy for phytotoxicity.

Further reading:
To obtain the report, *Quantifying the fertiliser value of wastewater sludges for agriculture* (**WRC Report No. 2131/1/15**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.