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Positive and negative impacts of composting and /or anaerobic digestion of sewage sludge on soil plant and water

NASSR Najat, PATUREAU Dominique, METZGER Laure, MOUGIN Christian



RITMO

Recherche Innovation et Transfert de Technologie pour les Matières Fertilisantes Organiques

Spreading of solid waste in agricultural soils


- Many organic pollutants enter in wastewater treatment plants,
- Wastewaters and sludge may undergo several types of treatments,
- The biological and physico-chemicals properties of the final sludge, as well as its content in organic chemicals, depend on these treatments.



Spreading of solid waste in agricultural soils

Aims of the EU project was to determine the safety and agronomic efficiency of sludge after spreading onto the soils, with respect to the type of treatment

5^{ème} PCRD
 contrat n° QLK5-CT-2002-01138
<http://www.biowaste.dk>

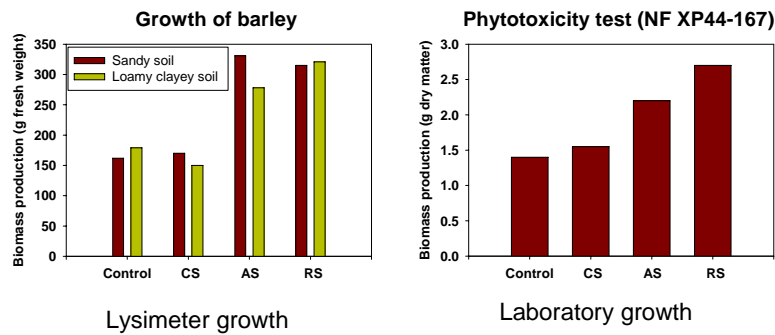


A **non transformed raw sludge (RS)** from urban origin (50000 equivalent inhabitants) was **anaerobically digested (AS)** and then **composted (CS)**.

- Different types of soils were spiked with the sludge samples in multiscale soil/plant/water systems:
 - the yields of crops, the ecotoxicological impacts and the dynamics of polycyclic aromatic hydrocarbons were assessed in lysimeters during one season,
 - microcosms were used to study the transfer of the contaminants from the soil to higher plants and leachates.
- The dynamics in a sandy soil of selected organic contaminants was studied in a long-term field experiment (25 years).

Agronomic efficiency

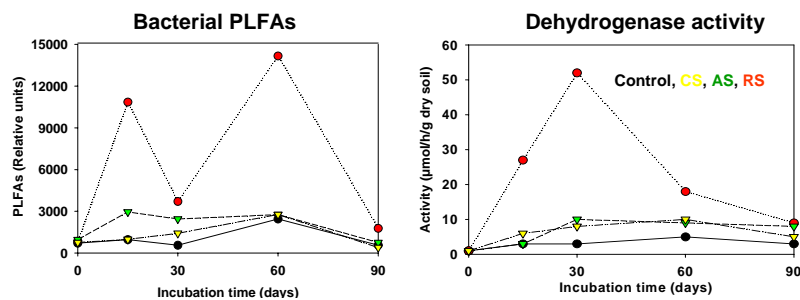
Effect on biomass production



► The most stimulating effects are noticed after **spreading the soil with RS** (sludge amount corresponding to 30 T dry matter/ha)

Agronomic efficiency

Effect on soil microbial communities



► Increased PLFA and dehydrogenase activity of soil microbial community during microcosms incubation depend on sludge treatment

Ecotoxicological impact

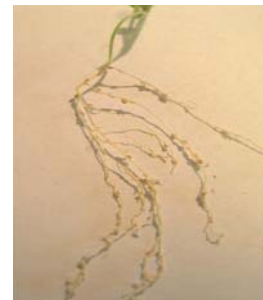
Rhizobium-red clover symbiosis

► No effect of the sludge on the growth of the red clover.



► The decrease of the number of nodules is high with RS.

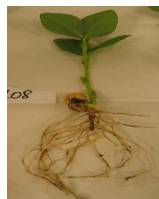
Sludge	Inhibition of nodulation (% of soil alone)
RS	84
AS	50
CS	30



Ecotoxicological impact

(Test adapted from NF T90-327)

Genotoxicity on the cells of Vicia faba



Sludge	Number of micronuclei / root cells
RS	1 - 4
AS	1 - 5
CS = control	0 - 1

► The sludge-induced genotoxicity is high with AS and RS

Fate of PAHs in the soil / sludge systems

In microcosms

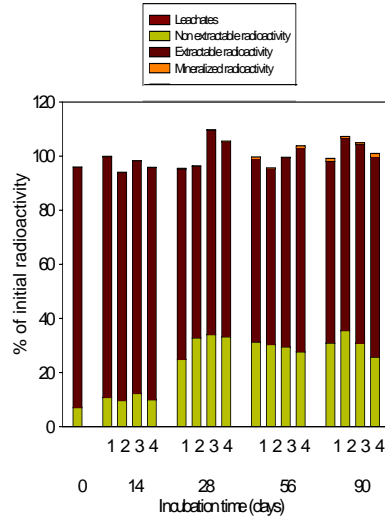
Spiking of sludge samples with 2 mg/kg of ¹⁴BaP

Spreading of spiked sludge to the clay soil at 30 T MS/ha

Laboratory incubation

Observation of wheat growth during incubation

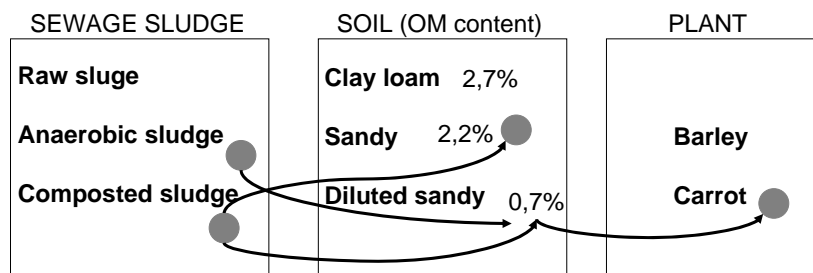
- ▶ BaP was **poorly mineralized** (less than 2%), **poorly stabilized as bound residues**, and remained extractable by solvents.
- ▶ BaP was not transferred to leachates and higher plants.



Fate of PAHs in the soil / sludge systems

In lysimeters

3 types of sludge / 3 types of soils / 2 types of plants



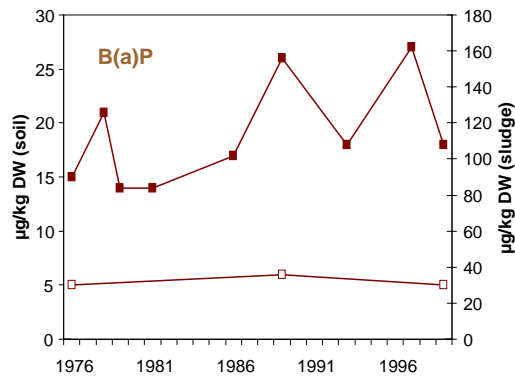
- ▶ PAHs were present in AS and CS, in the sandy soil spread with CS, on the root-peels of the carrots grown in the diluted sandy soil amended with AS and CS.
- ▶ High impact of **organic matter quantity and quality** of the sludge and soil on the fate of pollutants

Fate of PAHs in the soil / sludge systems

In a long-term field experiment

- Spreading of **100 T sludge/ha every 2 years** during **20 years (74 to 91)**

- Sampling during **25 years (74 to 99)**



► Repeated spreading of sludge with low contamination lead to **long-term accumulation** of BaP in the soil.

Conclusions

Impacts of the contaminants

► The highest effects are noticed with the raw sludge, no effect was noticed with the composted sludge

- Agronomic efficiency
 - no or positive effects on crop yields
 - no or positive effects on microbial descriptors
- Environment safety
 - toxic effect on symbiosis
 - genotoxic effect on root cells

Conclusions

Dynamics of the contaminants

- High impact of sludge processes and soil quality on contaminants fate
- Possible transfer to higher plant
- No transfer to soil leachates
- Long term accumulation of pollutants in the soil

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- Results - collaboration
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