Sustainable measures for sewage sludge treatment – evaluating the effects on P reaction in soils and plant P uptake

Moshe Shenker and Hana Einhoren
The Robert H. Smith Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel

RATIONALE
- Large P/N ratio in sewage sludge poses a limit to reusing this waste material as a soil amendment and nutrient source for plants.
- P buildup in soils may result in increased P loss to the environment, P increase in downstream surface water bodies, as well as adversely affect plant nutrition (Zn, Fe).
- Stabilization prior to application is proposed as a sustainable mean to allow beneficial use of this waste material.
- Methods to stabilize P in sewage sludge are available, but assessing P reactions in the sludge-treated soils, and its availability for plants is essential for validation of this approach.

OBJECTIVES
To assess P distribution among experimentally defined fractions and P availability for plants along time after incorporation of pre-treated sewage sludge materials into different soils.

EXPERIMENTAL
- Anaerobically digested sewage sludge was treated with either FeSO₄, Al₂(SO₄)₃, CaO, or stabilized through composting with yard-waste.
- Sandy, loamy, and clay soils were amended with the treated sludge materials or with reference P materials: glucose-1-P (GIP), inositol-hexaphosphate (IHP), and KH₂PO₄, all at a P-based rate of 50 mg P per kg soil.
- Amended and control (no additive) soils were incubated for 1, 7, 14, 35, and 112 days.
- Incubated soils were analyzed for P by a modified Hedley method (1) as well as as Olsen-P and a plant-based rapid bioassay (2).

REFERENCES

RESULTS
- Sewage sludge P reactions in soils depends on both, the stabilization method and soil properties.
- The available three P fractions (i.e., water, membrane, and NaHCO₃ extracts) pass the amount extracted by the Olsen method.
- The two most easily available P fractions (water and membrane P) were the major available fractions in the CaCO₃-free sandy soil and remained quite stable for months. In the presence of CaCO₃ (the other two soils) these fractions were converted to a more stable Ca-P phase.
- At an equal P addition to the soils P availability increased roughly by the order: KH₂PO₄ > GIP >> sludge > compost > Ca, Fe, Al sludge > control.
- IHP-P availability was negligible at the beginning and increased with time. The mineralization process was slow and was not complete 112 days after application.
- GIP-P was rapidly released and was as available as KH₂PO₄-P throughout the incubation period – both were fixed rapidly in all soils.
- All sludge materials had a net mineralization rate in-between that of the above reference organic-P sources.
- The bio-assay was highly correlated to the Olsen-P, as well as to the water extracted P and to the water extracted inorganic P, but not to the water extracted organic P.

CONCLUSIONS
- Phosphorus solubility and availability in soils amended with sludge can be effectively controlled.
- Using P-stabilized sludge materials will allow sustainable and beneficial use of sewage sludge.
- Stabilization with either Ca, Fe, or Al resulted in efficient long-term effect in the soils. The amount applied could maintain rather constant P availability.
- Thus – the stabilized phosphorus is stored in the treated soil and may provide P for the whole growing season, and probably to next growing cycles.
- As far as phosphorus is not commercially extracted from the sewage sludge, stabilization prior to application is proposed.