Enhancing the bioavailability of phosphorus from organic wastes

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Introduction

Fresh sources of phosphorus (P), are being rapidly consumed; from the viewpoint of circular economy, this utilization of single use resources is unacceptable. Therefore, as a plant nutrient of high priority, and a promoter of eutrophication, enhancing the recyclability of P is of great importance. As a part of Luke's ReP –project (Bioavailability of phosphorus in sewage sludges), the effects of lime stabilization (Lime), acid-oxidizer treatment (Kem), composting (Comp) and anaerobic digestion (AD) on the recyclability of P were studied in a two year field experiment with manure and sewage sludge, on oats and barley.

Materials and methods

The experiment ran on Luke experiment farms in Jokioinen in southwest Finland (clay) and Ylistaro (Silt loam) in western Finland, in years 2012 (oats) and 2013 (barley). Three levels of fertilization were used, with added nitrogen and potassium fertilization for determining P responses. The soils were fertilized only in 2012. NPK and NK fertilization were used as references. The fractions of P in the fertilizers remained quite constant regardless of treatment. The high solubility of P in manures was further increased by composting and decreased by AD. The sewage sludges contained mainly less soluble fractions of P, which was enhanced especially by the combined use of AD and lime stabilization (Fig. 1).

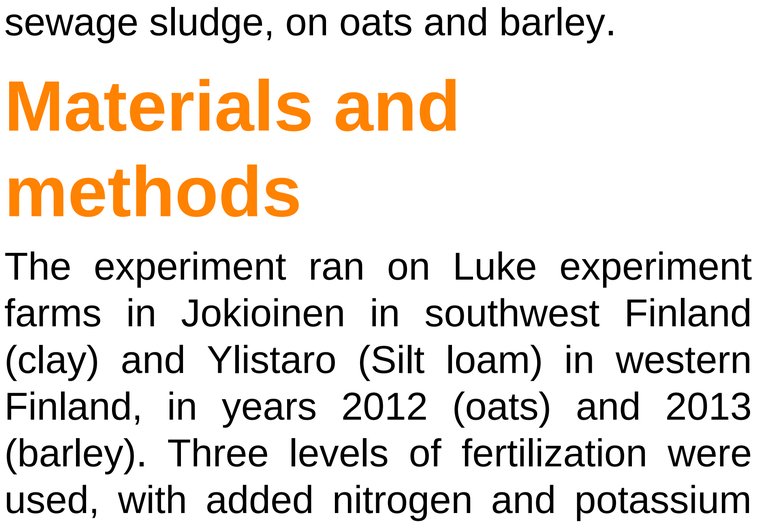

Fig. 1. Fractions of P in the studied organic fertilizers and soils.

Results

Crop yields varied between the fields, the silt loam soil (yield ~5.5 t/ha) providing greater yields than the clay soil (yield ~4 t/ha). The level of fertilization was not found to be significant for plant P uptake on the silt soil, even at very high levels; on the clay soil, the effect of fertilization level was however found to be linear. The results of both fields were statistically modeled at P input of 25 kg/ha to ease the comparisons between the fields. On the silt loam soil, the crop yields were smaller with the organic fertilizer products than with NPK (Fig. 2).

The results for the organic materials varied between fields. The plant P uptakes were mainly smaller with sewage sludges than NPK on the silt loam, while on clay the manures had smaller P uptakes. With clay, the differences between fertilizers were smaller than with silt loam, with composting increasing the plant P uptake. Overall the lime stabilization lowered P uptakes from sewage sludges (Fig. 2). No differences between fertilizer treatments were discernible in 2013.

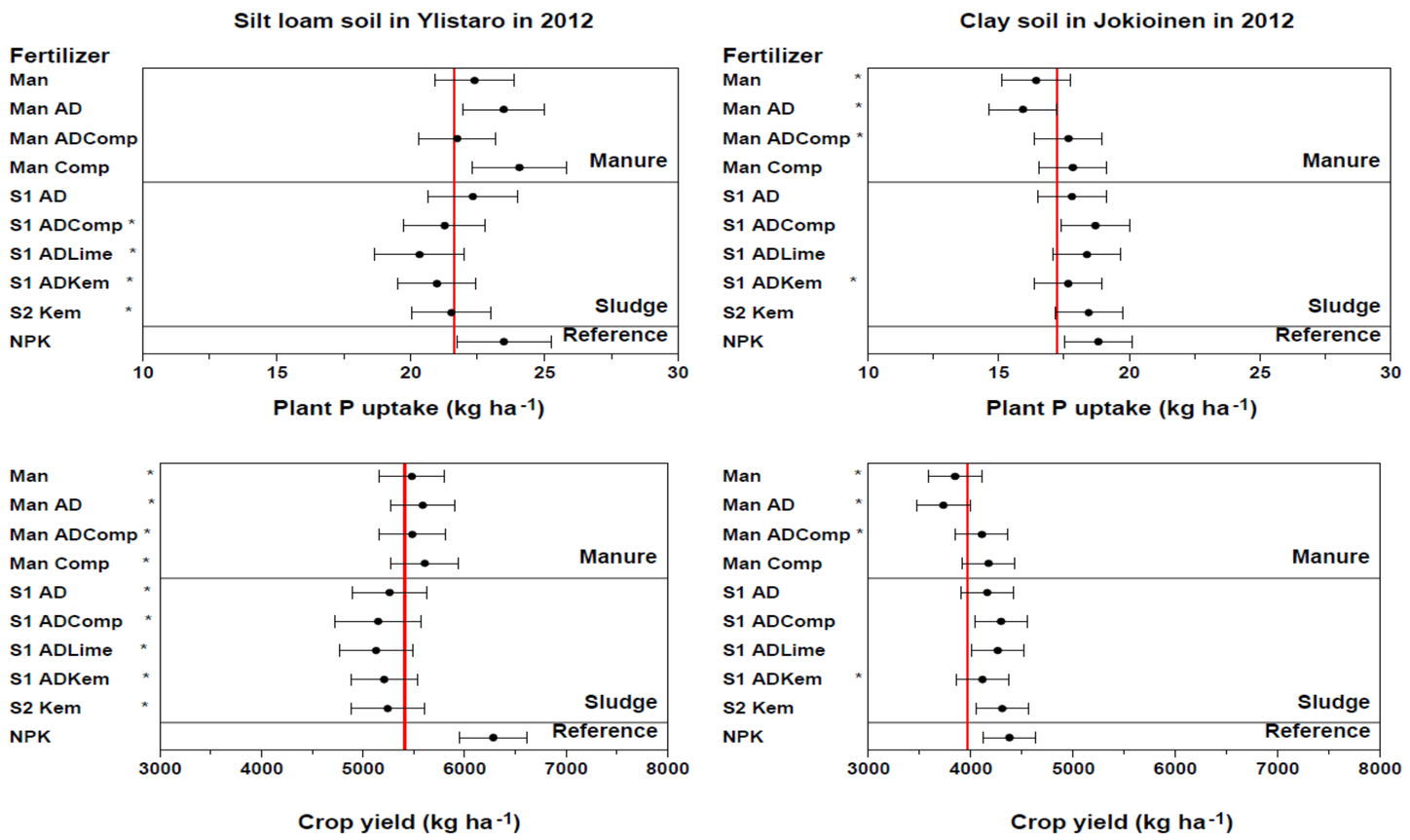

Fig. 2. The Plant P uptakes and crop yields of 2012 from Ylistaro and Jokioinen. NK-fertilization is shown as reference.

Conclusions

- **The P of sewage sludges was bound in less soluble forms than that of manure, but it was still plant available.**
- **Lime stabilization lowered the plant P uptake from sludge, probably due to formation of less soluble calcium phosphate in its high pH.**
- **Regardless of the low natural P states of the studied soils, the plant responses to organic fertilizers were low; the crop yield and P uptakes of NK fertilization was similar to that of the organic waste products.**
- **The differences of P fractions between the studied materials do not explain the differences in the plant P uptakes.**