Plant availability of P in sludges and manures

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Introduction

Interest towards phosphorus (P) rich by-products has increased due to the recent price peaks of P fertilizers and the estimated scarcity of primary P sources in the future. From the economical and environmental reasons, plant availability of P in these by-products needs to be known in order to adjust their application levels.

Material and methods

Barley (*Hordeum vulgare*, var. Elmeri) was grown on a sandy soil (6.5 kg) with a low plant available P content (P_{aaac}, 1.5 mg P l^{-1}), with following treatments: control (no P), anaerobically digested sewage sludges from two treatment plants [Biovakka Oy, Turku (S1) and HSY, Helsinki (S2)]. S1 originated from thermal hydrolysis process (150 °C, 3.5 bar, 20 min) and S2 was further composted with peat, CS2 (1:1, v:v) or stabilized with lime, LS2. Manure samples consisted of anaerobically digested dairy slurry (DS), pig slurry (PS) and fox manure (FM). Samples were air dried and sieved (6 mm) prior to application with following amount of total P: 150 mg P kg^{-1} of sludges and 40 of manures, except 100 as fox manure. Superphosphate (SP) was used as a reference with three application levels (10, 50 and 100 mg P kg^{-1}). Treatments were replicated four times.

Availability of P was evaluated by incubating the different P sources (Sludges: 150 mg P kg^{-1}, manures and SP 100 mg P kg^{-1} in above mentioned soil (70% WHC, 20 °C) for two weeks and analyzing P solubility with DGT method (Zhang et al. 1998). Hedley fractionation scheme (Sharpley and Moyer 2000) was used to determine P solubility in these P sources.

Results and discussion

In our experiment, barley growth was drastically supressed without P application (Fig. 1). Sewage sludge was a poor source for P due to its low solubility (Fig. 2).

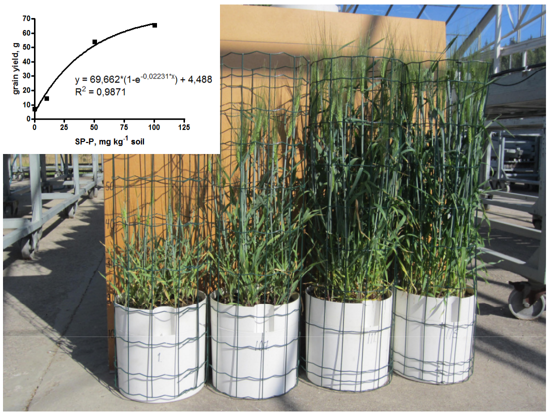

Figure 1. Barley shoots with increasing superphosphate application level (from left: 0, 10, 50 and 100 mg P kg^{-1} soil). Yield curve in upper left corner.

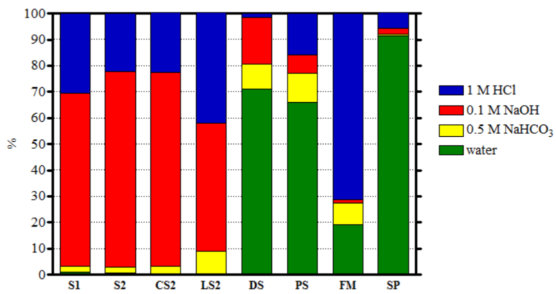

Figure 2. Solubility of P in different P sources according to Hedley fractionation.

P availability in LS2 was as high as 43 % of that in SP (Fig. 3), although Hedley fractionation indicated low solubility. DS and PS provided P for barley more efficiently than SP (Fig. 3).

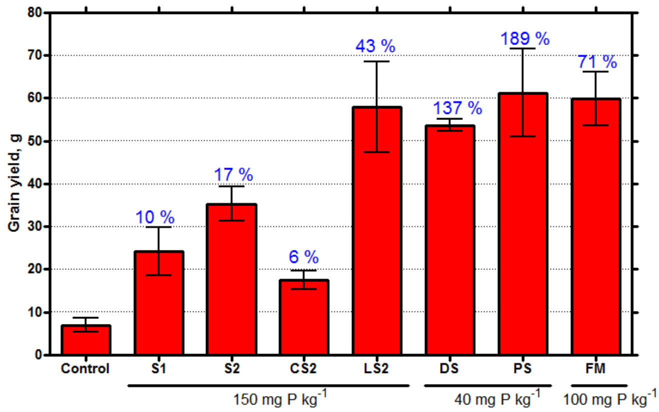

Figure 3. Grain yields with different P sources and P availability compared to SP is indicated above error bars (±SD).

The DGT-method predicted P availability from PS and DS accurately (Fig. 4). Solubilities of P from these sources corresponded to 184 and 121 %, respectively, of that in SP treatment. This reflects the actuall plant availability of these products (189 and 137 %, respectively). S1, S2 and CS2 increased P solubility least. Compared to Hedley fractionation, plant availability of P in LS2 was better demonstrated with DGT than with Hedley fractionation scheme.

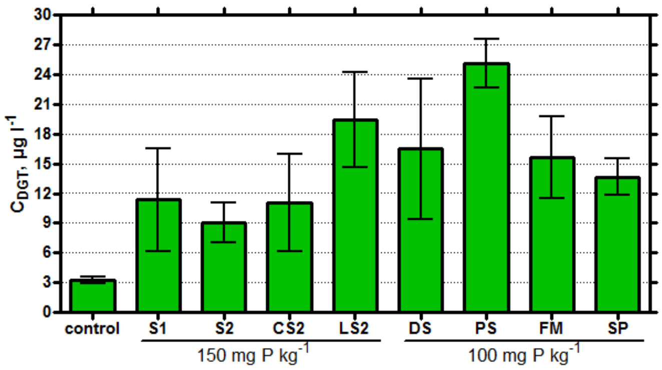

Figure 2. Increase of P solubility in soil after 2 weeks incubation according to DGT-method.

References
Sharpley, A.N. & Moyer, B. 2000. Phosphorus forms in manure and compost and their release during simulated rainfall. Journal of Environmental Quality 29: 1462-1469.
Zhang, H., Davison, W., Knight, B. & McGrath, S. 1998. *In Situ* measurements of solution concentrations and fluxes of trace metals in soils using DGT. Environmentally Science and Technology 32: 704-710.