Effect of compost on soil phosphorous availability

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ABSTRACT

Deficiency of plant available phosphorus (P) is common in many soils, therefore application of inorganic P fertilisers is used to overcome P deficiency. The low use efficiency of inorganic P fertilisers has increased interest in the use of alternative sources of P. Application of organic materials like manure, plant residues and compost has been shown to increase P availability and inorganic fertiliser use efficiency and diverts these wastes from landfill. Little information is available about the effect of composts prepared from different feed stocks and with different particle sizes on P availability and P uptake by plants in different soils or their effect on rock phosphate solubility in neutral and alkaline soils. The aims of this study were to (i) determine the effect of different composts on soil P pools and P uptake by wheat, (ii) compare the effect of composts types and application methods on solubility of rock phosphate and P uptake by wheat, (iii) determine the effect of compost particle size on P pools and microbial biomass in soils differing in pH, clay and organic matter content.

An experiment with different composts was conducted in a loamy sand soil with low P availability and wheat was grown until grain filling. The composts were derived from animal manure and straw (C1), garden waste (C2), wood chips and bark (C3) or kitchen waste (C4) and differed in total C, N and P as well as in available P concentration. Soil P pools, soil respiration, plant dry weight and P uptake were measured on days 14, 28 and 72. Composts with high P availability increased labile P pools more than those with low P availability. From 14 days onwards, P availability decreased and organic P and less labile P pools were formed. Wheat P uptake was highest with fine textured composts with low C/N and C/P ratio and lowest with coarse textured compost.

Two experiments were conducted using different composts applied as mulch or incorporated into the loamy sand soil into which rock phosphate was mixed and wheat was grown until grain filling. The composts C1 (from garden waste) and C2 (from wood chips and bark) differed in C/P ratio, C/N ratio, total P and available P concentrations. Compared to rock P alone, the combination of compost and rock P increased the concentration of available P (microbial P and $NaHCO_3$-Pi) and plant P uptake. However when compost was incorporated in soil with rock phosphate, the concentration of available P and plant P uptake were higher than expected by the addition of P with the compost alone. Thus, compost incorporation increased the solubility of rock P. The combination of compost and rock phosphate also increased the concentration of NaOH-Pi and HCl pools indicating effects on P flux between pools. These compost effects were greater when the compost was incorporated compared to application as mulch.

An incubation study was carried out to compare the effect of compost particle size on soil P pools and microbial biomass in soils differing in pH, clay and organic matter content. Compost from garden waste was sieved to particle sizes > 5 mm, 3-5 mm and < 3 mm and these fractions were mixed into three different soils at the same rate of total P added (50 mg P kg^{-1} soil). Soil respiration and microbial biomass and soil P pools were measured on days 25 and 50. Soil respiration was higher with the coarser particles whereas microbial biomass was greater with finer fractions. The size of the P pools was mainly affected by soil type. The effect of the compost was small but the compost fractions differed in their effect on available P with a greater increase by the finest fraction compared to the coarser fraction. Irrespective of compost addition, the acidic soil had the highest concentration of Al and Fe associated P, whereas Ca associated P dominated in the alkaline soil. The size of most P pools including so-called stable P

pools like NaOH-P and HCl-P changed over time in amended and non-amended soils. It can be concluded that the size of P pools is more strongly affected by soil properties such as organic matter content, texture and pH than by the compost fractions.

A glasshouse experiment with four soils (K1, K2, B1 and B2) with different properties was conducted to compare P uptake of wheat and the size of soil P pools in four soils differing in pH, organic matter content and texture. Wheat was grown for 63 days with or without compost (from garden waste) applied as layer on the soil surface. The treatments also included unamended soils. Plant P uptake was greatest in K2 and B2 soils with high organic matter content and higher in plants amended with compost compared to the plants without compost. The concentration of most P pools was higher in the heavier textured soils (K2 and B2). On day 63, the presence of plants increased the concentration of water-soluble P in soils K2, B1 and B2 but only when not amended with compost. The concentrations of microbial P and $NaHCO_3$-Pi were higher in the planted than the unplanted soil irrespective of compost addition. On the other hand, the $NaHCO_3$-Po concentration in soils K1, K2 and B2 was lower in the planted compared to the unplanted soil. Thus, although the plants removed P from the soil via P uptake, there was no consistent decrease in P pool concentrations and the concentrations of some of the inorganic P pools (NaOH-Pi, residual P) and NaOH-Po were greater than in the unplanted soil on days 0 and 63. This suggests that plants stimulate the formation of stable inorganic and organic P pools possibly by increasing microbial activity. Compost addition to the plants increased plant growth and P uptake but had little effect on the P pool concentration even in soil B1 which had the lowest P pool concentrations. This suggests that the P added with the compost was readily taken up by the plants and was not converted into soil P pools by the end of the experiment.

DECLARATION

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