Improving rock phosphate availability through feeding, mixing and processing with composting manure

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Abstract

The objective of this study was to improve the availability of phosphorus (P) from rock phosphate (RP) through feeding, mixing and composting manure. The experiment was conducted as a 3 × 2 split-plot design. Manure was collected from 12 Boran steers (200 ± 4.5 kg live weight) fed a basal diet of Napier grass (Pennisetum purpureum) at 2.5% body weight on a dry matter (DM) basis. The main plot treatments were (i) manure from steers supplemented with 113 g Busumbu rock phosphate (BRP) per day (FBRP), (ii) manure from steers not supplemented with BRP, feces mixed with 113 g BRP per day (MBRP) and (iii) manure from steers not supplemented with BRP and feces not mixed with BRP (CONT). The sub-plots comprised composting the manure either (i) mixed with 440 g of wheat (Triticum aestivum L.) straw per kg fresh feces (WS) or (ii) without straw (WOS). The manure was composted in 200 L plastic bins for 90 days. After 90 days, P availability was evaluated (i) by aerobic laboratory incubation at 25 °C for 1, 2, 4, 8, 12, and 16 weeks and (ii) by greenhouse agronomic evaluation study using maize (Zea Mays L.) as the test crop in either a humic Nitosol or an Andosol. In the laboratory incubation study, resin P was higher ($p < 0.05$) for the WS compost than for the WOS compost; values were higher ($p < 0.05$) for the Andosol than for Nitosol and followed the order of FBRP–WS, Andosol > FBRP–WS, Nitosol > MBRP–WS, Andosol > MBRP–WS, Nitosol > FBRP–WOS, Andosol > FBRP–WOS, Nitosol. In the greenhouse evaluation, maize crops in the WS compost had higher ($p < 0.05$) biomass yield than the reference fertilizer, triple super phosphate, (173% versus 196%; Andosol and Nitosol, respectively). The biomass yield and P uptake relative agronomic effectiveness (RAE) for WS compost was also higher ($p < 0.05$) than that of WOS compost (184 versus 3 ± 0.8 and 242 versus 162 ± 0.2, WS and WOS, biomass yield and P uptake, respectively). Nitosol biomass yield and P uptake RAE were also higher ($p < 0.05$) than for the Andosol (99 versus 88 ± 0.8 and 332 versus 72 ± 0.2, Nitosol and Andosol, biomass yield and P uptake, respectively). The results show that P-enriched composting in the presence of wheat straw significantly increased P availability and increased plant growth. However, in terms of plant growth, there was no additional benefit of first feeding the RP to steers before composting the manure because most of the RP fed seem to have been utilized by the animal.