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Testing a biological method to increase solubility of sewage sludge ash phosphorus

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Phosphorus is an essential plant nutrient. World-wide phosphorus reserves will be exploited in the next 50-100 years, reserves with low uranium and heavy metal contamination even sooner. This poses a problem also for organic agriculture, where currently only the use of soft ground rock phosphate is allowed. Human excrement contains relatively high amounts of phosphorus, which are largely unused at the moment. The strategy chosen by the City of Vienna to make use of this phosphorus reserve is the separate incineration of sewage sludge. The subsequent utilization of the sewage sludge ash (SSA), however, is hampered by its low phosphorus solubility and plant availability.
This study investigates biological methods to increase solubility and plant availability of SSA phosphorus. Here we report the results of four experimental runs of incubation of sewage sludge ashes with different composts. SSA addition to compost fresh matter varied from 3 - 33%. Experimental conditions were 4 °C / 30 °C / 55 °C, aerobic/anaerobic, and with/without the addition of calcium ammonium nitrate / urea / sulfur / mould fungi. Phosphorus solubility was determined in water extract (OENORM EN 15958, 2012), NAC extract (neutral ammonium citrate; 0,9M citric acid + 2,7M ammonia pH=7; OENORM EN 15957, 2011), and CAL extract (0.05M-Ca-lactate + 0.045M Ca-acetate (=0,045 M) + 0.313M acetic acid pH = 4,1; OENORM S 2021, 2017) using ICP-OES.
Lowering SSA addition from 33 % to 3 % tended to increase P solubility in NAC extract, while no such effect was found in the other extracts. Extending the incubation process from two to six weeks resulted in an increase of the P solubility in CAL extract, with varying effects in water and NAC extracts. Supplementing the experimental mix with nitrogen, either as calcium ammonium nitrate or as urea, had little effect on P solubility, except in the 6 week-experiment. The influence of lowering pH on P solubility was tested with addition of elemental sulfur, which decreased pH from 8.5 to 6.3 on average of all treatments. Lowering the pH increased P solubility in water extract, but had no effect on the P solubility in CAL and NAC extracts.
In water extract, P solubility increased from zero to max. 1.06 % of total P concentration of the sewage sludge ash through the experimental treatments. In CAL extract, P solubility rose at maximum from 1.0 % to 8.8 % of SSA Ptot. P solubility in NAC extract increased from 7.7 % to 19.9 % of Ptot. These maximum solubility increases were obtained in a treatment with addition of 12.5 % SSA + 90 mg l-1 urea-N + mould fungi. On average of all 42 treatments tested, P solubility in water extract increased to 0.53 % of SSA Ptot, in CAL from 1.3 % to 3.7 % and in NAC from 9.4 % to 14.9 % of SSA Ptot.
As compared with the P solubility of rock phosphate the results look promising, they will be continued with focus on measures to increase microbial activity.