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Short Communication

Carbon sequestration in the soil fertilized with digestate as a method of mitigating the CO^2

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Abstract:

The currently observed increase of the CO2 concentration in the atmosphere contributes to the global warming. Carbon sequestration is one of the ways to mitigate the CO2 emissions to the atmosphere. Soil can play a significant role in carbon retention and reduction of the greenhouse effect. On the other hand, soils especially degraded ones and that used as agricultural land require fertilization. One of the method of improving the fertility of the soils involves using the organic waste, which can be a valuable source of nutrients and has a positive effect on the physical and physicochemical properties of soils. The effect of digestate properties on carbon fate in soil were the aim of the study. The pot experiment with using slightly acid soil and two types of digestates, from the biogas plant and the anaerobically stabilized sewage sludge from a municipal wastewater treatment plant were conducted. The digestates were added to the soil in doses that increase the initial carbon concentration to 2% dry weight, and the pots which included the soil-waste mixtures and soil alone (as control sample) were incubated at 20C for 60 days in thermostated chamber. During the experiment the soil samples (in three repetitions) were taken four times, after the 1st, 3rd, 6th and 9th week. The significant decrease of organic carbon content were observed until the 6th week, and then the carbon content was stabilized. In the soil without amendments, the content of organic carbon did not change significantly.

Introduction:

Over the last decade, European Union policy oriented towards developing a circular and resource-efficient economy has encouraged a rapid increase of anaerobic digestion installations. The number of AD installations in the EU rose from 6227 to 17,662 between 2009 and 2016, with a main focus on AD of residues from food and feed industries, sewage sludge, animal manure, and landfill waste. While biogas is the primary product from AD, millions of tonnes of digestate are generated annually as a by-product. Digestate requires appropriate management or disposal to prevent over-fertilisation in regions with an excess of manure and digestate as well as storage problems. Digestate is typically separated mechanically into liquid and solid fractions as a simple procedure to overcome transport constraints and facilitate application to soil. The liquid fraction typically contains a significant amount of nitrogen (N), mainly in the form of plant available ammonium-N, and can be used as a N-fertiliser. The solid fraction, on the other hand, has a high dry matter content, is rich in phosphorus (P) and organic carbon (C), and has the potential to be used as a P fertiliser and an organic soil improver.

The recently approved Fertiliser Regulation makes a distinction between "organic soil improvers" and "solid organic fertilisers" primarily based on the nutrient content and the intended use of the biosolid. While solid organic fertilisers are added as sources of readily available plant nutrients, organic soil improvers are added primarily as sources of organic matter (OM) in order to ameliorate soil physicochemical and biological properties. When OM is added to soil, microorganisms use it as a source of energy thereby emitting CO2 via respiration. Hence, only the fraction of OM that is less degradable remains and eventually contributes to soil organic matter. This stable fraction of the original OM that remains after 1 year is often referred to as the "effective organic matter" (EOM). In order to be classified as an organic soil improver, proposed that the EOM to mineral-N ratio must be higher than 150 and the EOM to phosphate (P2O5) ratio must be higher than 35.

Conclusion:

The C and N mineralisation potential of P-POOR SF was compared with conventional SFs of digestate to study the stability of the present OM. The results showed that the humification coefficient does not correlate with the C/N ratio, HWEC or WSC. It therefore seems that the nature of the organic matter was the main factor controlling C mineralisation in the treatments. Temporary N immobilisation was observed in P-POOR SF and SF after screw press, and this was attributed to their high C/Norg ratios. In biochar (BCHR), no N immobilisation was observed despite its high C/Norg ratio which is due to the high humification coefficient (91%) of the biosolid, meaning that there was no need for mineral N to sustain microbial growth. The other tested biosolids, SF after decanter (DEC-SF), SF after decanter and drying (DRY-SF), and compost, showed a near linear positive N mineralisation. There was no correlation between the HC and %N mineralisation. When considering the amount of effective organic matter (EOM) that can be applied to soils within the phosphate limits, i.e. the EOM/P ratio, P-POOR SF had the highest potential to be used as an organic soil improver among the SFs. As such, reducing the P concentration in SFs facilitates their application in many European soils. These results highlight the agricultural value of SFs of digestate for soil organic matter and their potential limitations in P-rich soils.