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Simultaneous determination of organic carbon and nitrogen mineralization capacity of sewage sludge-based compost

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Amongst the main problems in the rational utilization of composted organic matter are the stabilization level which can drive towards phytotoxicity and the nitrogen mineralization capacity which is strictly related to the environmental issues in addition to the plant nutrition request (Bernal et al., 1998). The rapid determination of both characteristics is an important goal in the rational use of organic matter in soils as well as in container cultivation (Baffi et al., 2007, Grigatti et al., 2007).

In this work three blends, prepared by mixing different quantities of tree pruning (LC), agro-industrial processing waste (AI), wastewater sewage sludge (WW) and a mixture of AI+WW, were composted over a 3-months period. During the composting process the blends were monitored for the main physical and chemical characteristics: pH, electrical conductivity (EC), total organic carbon (TOC), total Kjeldhal nitrogen (TKN), total extracted organic carbon (TEC), humic-like acids + fulvic-like acids (HLA+FLA). Furthermore at days 0, 15, 30, 60 and 90 the mixtures were tested for the stability by means of the measurement of the oxygen uptake rate (OUR, in mmol O_2 kg^{-1} VS h^{-1}) in a standardized liquid aerobic incubation at 25˚C over one week (Grigatti et al., 2007). The liquid was plenty of nutrients and buffered at pH 7, the nitrification activity was suppressed by N-Allylthiourea. This allowed the testing of the nitrogen mineralization capacity on 0 and 90 days compost mixtures samples by

means of the solely NH_4^+-N determination in the liquid suspension.

Sewage sludge origin affected all the initial mixture characteristics, the TOC content decreased from 32.5% of CP_{AI} to 30.2% and 28.2% of the mix CP_{AI+WW} and of CP_{WW}, respectively. The TOC content progressively decreased, 32% on average over the 3-months period, due to the process of mineralization. CP_{AI} had the highest mineralization (42.5%), occurring mostly during the first week, followed by CP_{AI+WW} and CP_{WW}, with 30.8% and 21.7%, respectively. The TKN concentration was similar for CP_{AI+WW} and CP_{WW} (1.75%) and lowest for CP_{AI} (1.47%) at the beginning of the process with a progressive depletion during composting. The highest TKN losses (-26.6%) were found in CP_{AI} while CP_{AI+WW} and CP_{WW} showed a similar reduction (about -16.6%) respect to the initial TKN value. The stabilization level (OUR) at day 0 was 78.6, 56.5 and 38.5 mmol O_2 kg^{-1} VS h^{-1} in CP_{AI}, CP_{AI+WW} and CP_{WW} respectively. CP_{ww} was the most stable and showed the lowest reduction during composting. At the and of composting all mixtures showed similar values, 13 mmol O_2 kg^{-1} VS h^{-1}, on average.

Data analyzed on the basis of the exp model $y = ae^{-kx}$ ($k = d^{-1}$) showed a very good fitting CP_{AI}: k = 0.0244, R^2 = 0.89*, CP_{ww}: k = 0.0178, R^2 = 0.89*, CP_{AI+WW}: 0.0191, R^2 = 0.99***. The nitrogen mineralization capacity determined in the liquid environment showed all the fresh mixtures had an initial intense immobilization of the added nitrogen. CP_{AI} showed the deepest (-55.6%), followed by CP_{AI+WW} (-23.5%) and CP_{ww} (-9.23%). The fresh CP_{ww} showed a constant immobilization process, whilst other mixtures showed a rapid mineralization after the immobilization phase, which anyway never became positive. On the contrary the stabilized compost (90 days) showed always a positive N-mineralization, 1.41, 1.17 and 0.31% in CP_{AI}, $CP_{ww}$and CP_{AI+WW}, respectively. These were preceded by a slight immobilization phase which was -0.49, -1.10 and -0.64% in CP_{AI}, CP_{ww} and CP_{AI+WW}, respectively. The results are in agreement with those reported in literature on this kind of products at different stabilization stages (Bernal et al., 1998).

The adopted method showed a very good capacity to determine the organic matter stabilization level and the nitrogen mineralization capacity of the sewage sludge-based compost in a very short time (7 days) and it represents a potential important tool in the modeling and for a decision support system.

1 References

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