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Nutrient utilization efficiency and soil carbon management index (CMI) following the use of compost in open field on cereals crops

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Abstract

The European Union (EU) is currently promoting the recycling of organic waste for agricultural purposes to restore soil organic matter (SOM), thus preserving soil fertility and supplying nutrients to plants as an alternative to chemical fertilization. However, there is still limited information on the agronomic benefits of using these products in medium- and long-term field trials. In this light the aims of this study were: (ì) the investigation of the plant nutrients (N; P) uptake following the distribution of different types of compost; (ìì) the study of the SOM variation; and (ììì) the investigation of the soil functions via the assessment of the Carbon Management Index (CMI), over 3 year in a field plot test. In this framework two agronomical pathways were compared: continuous and pulsed compost application (every year / every 3 years), the latter followed by solely chemical nitrogen (N) fertilization. Three types of compost: from bio-waste (BWC), from anaerobically digested bio-waste (DC) and from urban/agro-industrial sludges (SC), were compared in this study along with a chemical N-P-K fertilizer (Chem) and a unamended control (Ctrl). The study revealed Path 1 performed high relative agronomic efficiency (N-EAR% vs. Chem): SC (118)> DC (114)> BWC (109), indicating a general benefit in the use of the chemical N fertilizer following basal compost application. In Path 2, the N-EAR (%) was highest in BWC (112)> DC (105)> SC (74). Indicating SC performed lower N-use efficiency, consistent with its high C:N ratio and biological stability (OUR). The N-EAR obtained following the application of N fertiliser, always >100%, proved to be an effective strategy to maximise plant N use, valorizing also the residual P applied with organic fertilisers, in almost all cases. The P balance was consistent with the inputs and removals, revealing an important accumulation of total and inorganic P following the continuous application of compost. This aspect deserves further investigation in light of the EU guidelines on P efficiency maximizing. The two paths highlighted the different SOM kinetics. The single application of compost ensured a significant initial SOC increase, between 10 and 25% (SC and DC) at the end of the first year, returning to the background at the third year. On the contrary, following continuous applications of compost, a constant accumulation of SOM was observed, from 10 up to 40% from the first to the third year on average. Besides the quantitative changes in the SOM, its 'functionality' appears increasingly. To this end, an index has been successfully adopted

in research in this area, the CMI: Carbon Management Index (Lou et al., 2011). This parameter, from the combination of total organic C and the labile fraction (oxidizable with KMnO4), is very sensitive to changes that may occur as a result of different fertilization management. The tested composts were optimal substitutes for chemical fertilizers and fertility restorers with a general increase in SOM soil functionality. Overall the treatments showed higher N efficiency used in combination with the chemical fertilizer, also presenting a good ability to supply P over the three-year period.

Keywords: Compost; Soil Organic Carbon; Nutrients

References

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