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Original Research Article

Monitoring the variation of soil quality with sewage sludge application rates in absence of rhizosphere effect

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ABSTRACT

Agricultural soils in semi-arid regions have frequently been degraded due to adverse climatic conditions, organic matter depletion, and poor farming practices. To enhance soil quality, this study examines the reuse of sewage sludge (SS) as an available source of organic matter in a typical Mediterranean sandy-loam soil. Accordingly, we studied the cumulative effect of two annual applications of 40, 80 and 120 tons of sludge per ha on soil quality in absence of vegetation. The dose-dependent improvement of organic matter content was the most significant event that reflected sludge application rates, and consequently influenced other soil properties. Accordingly, soil structural stability increased by 13.3%, 28.8% and 59.4% for treatments SS-40, SS-80 and SS-120 respectively as compared to unamended control. Structural stability improvement was also confirmed by the dose-dependent variation of other edaphic factors including calcium content, the microbial quotient as well as Welt and C:N ratios. These parameters are involved in cementing soil aggregates by cation bridging, the formation of microbial mucilage, and clay-humic complexes. Soil magnetic susceptibility (SMS) was measured in situ as a possible rapid tool to evaluate soil condition. SMS showed significant correlation with sludge dose and stability amelioration testifying to the aggregation role that can play Al_2O_3 and particularly Fe_2O_3 minerals added by the hematite-rich sludge. Besides, analytical results and field observations revealed no trends of soil salinization or acidification by excessive sludge amounts. By avoiding the rhizosphere effect, outcomes could reflect the resilience and intrinsic capacity of the soil to cope with excessive sludge loads.

1. Introduction

Degradation of productive croplands has been of a great economic concern due to its impact on current and future production and implications on food security. Global estimates of total degraded lands vary from less than 1 billion ha to over 6 billion ha, with equally wide disagreement in their spatial distribution (Gibbs & Salmon, 2015). In any case, improving soil quality contributes to minimize arable land degradation and allows for better sustainable agricultural practices. On the other hand, semi-arid soils in particular are more vulnerable to degradation because they store little organic carbon (Janzen, 2004); whereas these soils possess a great potential for carbon sequestration after organic amendments (Lal, 2009). Therefore, enriching soils with exogenous organic matter is a major practice that restores degraded soils in semi-arid regions (Masciandaro et al., 2013; Zoghlami et al., 2016).

It has historically been proved that the valorization of agricultural wastes such as farm manures or plant residues improves the fertility of soils by enhancing their structure, nutrient content, hydrodynamics properties, and biological activities (Adediran et al.,

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