Introduction

In West Africa, smallholders integrate crop and livestock. This integration plays an important role in agricultural productivity, increases SOC and improves soil fertility [1]. Carbon sequestration involves increasing the stocks of soil organic carbon (SOC) stable forms, while improvement of agricultural productivity requires labile SOC forms which can release essential nutrients for plant growth [2]. Meeting these two challenges (productivity and mitigation) simultaneously requires documentation of both the quantity and the quality of SOC [3]. Rock-Eval pyrolysis is a simple and fast method for obtaining information on the carbon content and thermal stability of organic matter [4]. In the context of soil science, this technique is recommended for quantitative and qualitative characterization of soil organic matter (SOM).

Study sites

Agro-ecological description of the sites

- Sudan-Sahelian climate (average annual temperature: 30 °C)
- Short rainy season from July to October (average annual rainfall: 530 mm)

Materials

- Arenosol (with sandy fraction > 90%)
- Low SOC in topsoil [1.6 - 1.9 g.kg⁻¹ soil; Median: 4 g.kg⁻¹ soil]
- +Millet residues
- +Organic wastes
- No input

Methods

Rock-Eval pyrolysis (RE)

- Thermal analysis method of the organic matter where the fractions of HC, CO, and CO₂ are measured
- Studied signal: S2 thermogram (Figure 2) - Integration between the predefined temperature limits.
- Pools linked to thermal stability of SOM
  - Labile pool: A1 at [200-400 °C]
  - Resistant pool: A3 at [400-460 °C]

Results & Discussion

Result 1: Specific RE signature of the Arenosols

- Relative enrichment compared to [4] in the most refractory A5 pools in all situations, independently from organic inputs (Figure 3)
- Arenosols of Senegal = R index higher than in the reference Ferralsols’ dataset
- Arenosols of Senegal = Specific signature marked by 1 index more important in deep layer than in the reference data set [4]
- Deviation of the values observed in Senegal compared to the model obtained with a reference data set [4] = calculation of a Delta1 (Figure 4)
- Delta1 strongly correlated with A5 and anti correlated with A3 and A4 (Table 1)

Result 2: Organic inputs ensure the link between quantity of SOC and quality of SOM

- Quality of SOM in 0-10 cm differs from quality of SOM in 10-30 cm
- +Millet residues and +Organic wastes have similar S2 thermograms, as bi-modal in 0-10 cm
- Important labile pool and stable pools in 0-10 cm soil layer
- Relative enrichment of A3 and A4 in 10-30 cm soil layer

Conclusion

The Arenosols of the Senegal groundnut basin have a specific thermal signature in the Rock-Eval’s I/R diagram. In these soils a slightly higher mineralization of labile also but of more resistant thermal pools benefits to food security but not to climate change mitigation. Our results show that the quantity of SOC and the quality of SOM are linked in preserved, +Millet residues and +Organic wastes situations. However, they are not correlated in the No-input situations. This result shows that the organic contribution, whether natural or exogenous, guarantee the link between the quantity of SOC and the quality of SOM. Ultimately, this study highlights the importance of maintaining regular organic inputs to these arenosols to maintain soil fertility.

References


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