1137

Effect of Organic Amendments on the Heavy Metal Distribution in Market Gardens in Senegal

A. Diouf[1], M. Eick[1] and F. Feder[2]
[1]Virginia Tech, Department of Crop and Soil Environmental Sciences, 185 Ag Quad Lane, Blacksburg, VA 24061
[2]CIRAD, Laboratory of Microbial Ecology of Soil and Tropical Agrosystems, Bel-Air, B.P. 1386, Dakar - SENEGAL

INTRODUCTION

As in many African countries, most Senegalese soils are sandy and consequently low in organic matter content. This problem of soil fertility is due to climatic variability, excessive deep tillage and the use of chemical fertilizers.

Degraded and low quality soils are not fertile and thus cannot maintain sustainable production. Therefore, strategies for using organic wastes in agriculture must be developed. This can be beneficial because organic matter improves soil physico-chemical and biological properties.

However, the use of organic waste as fertilizer and soil amendment may have negative impacts on the environment due to the possible presence of heavy metals.

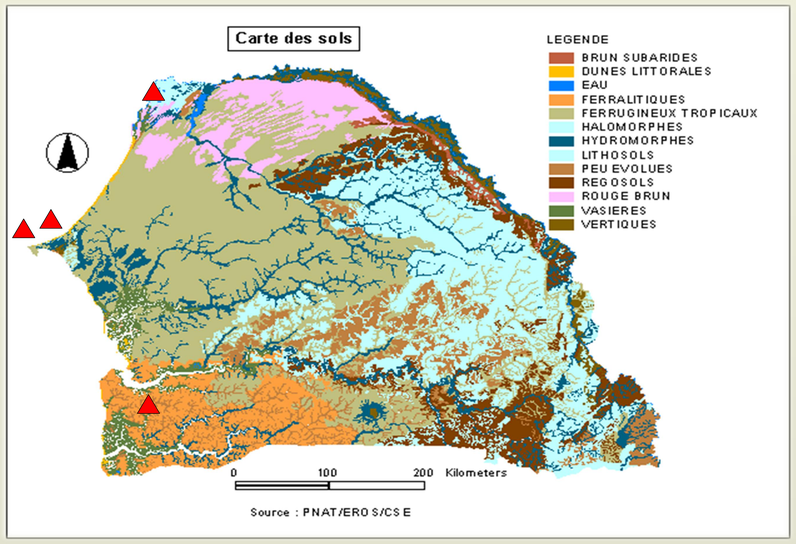


Figure 1: 4 Sites in Senegal

OBJECTIVES

The accumulation of heavy metals in the environment represents a potential risk to human health due to their possible uptake by plants and their subsequent introduction into the food chain.

As a result, this study aims to identify and quantify heavy metals in market gardens soils, in order to gain a better understanding of their potential impact to human health.

MATERIALS AND METHODS

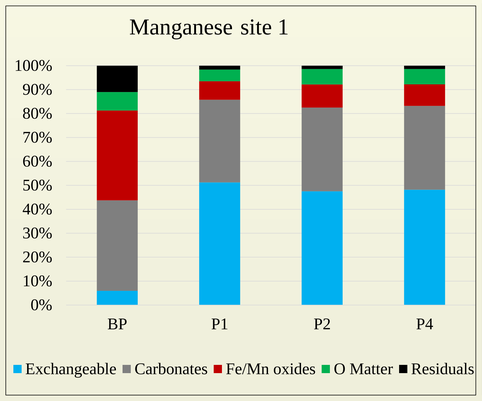
Because of the sandy nature of the soils, all composite samples were collected from 0 to 15 cm depth. Three of the sites are located in the Niayes Region, which is an urban agriculture zone providing more than 80% of vegetables to the local markets of the capital city of Dakar. The fourth site located in Ziguinchor, South West Senegal, where a social development project is training women in good market gardening practices.

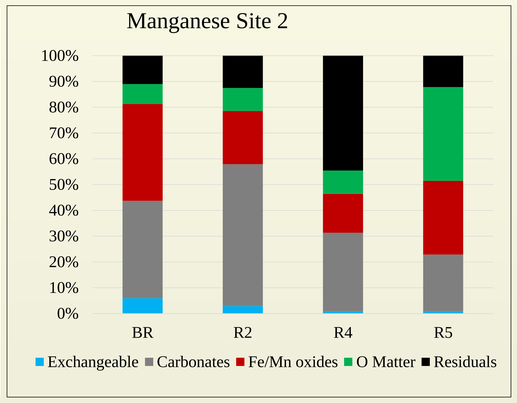
Soil samples were first characterized for particle size, pH, surface charge and carbon content. Tessier and al. (1979) Sequential Extraction Procedure (SEP) was used to determine heavy metal sinks (Co, Cu, Cd, Cr, Mn, Zn, Ni and Pb).

Fraction	Solution	Equilibrium conditions
Exchangeable	8 ml 1M MgCl2 (pH 7)	1h, room temperature
Carbonates	8 ml 1M NaOAc (pH 5)	5 h, room temperature
Fe and Mn oxides	20 ml 0.04M NH2OH/HCl in 25% (v/v) HOAc	6 h, 96°C + 3 agitations
Organic matter	3 ml 0.02M HNO3 + 5 ml 30% H2O2 (pH 2)	2h, 85°C
Residual	HNO3-HCl digestion (3:1)	20 min, room temperature

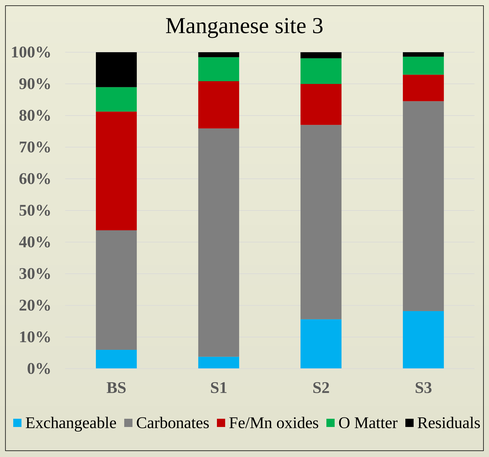
Table 1: Summary Tessier Procedure

RESULTS





In all sites, Mn tends to be associated with the exchangeable and carbonate fractions. Based on the background concentration, Mn increases with OM addition.



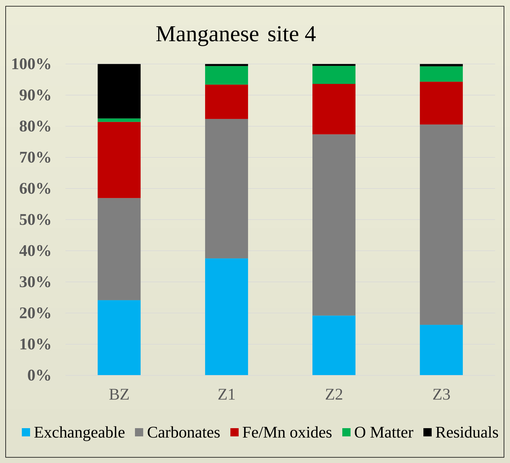
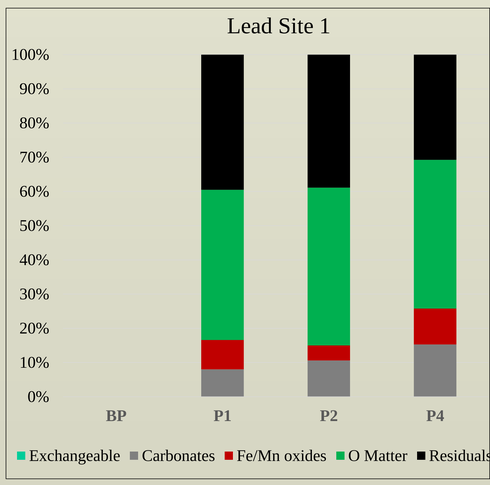
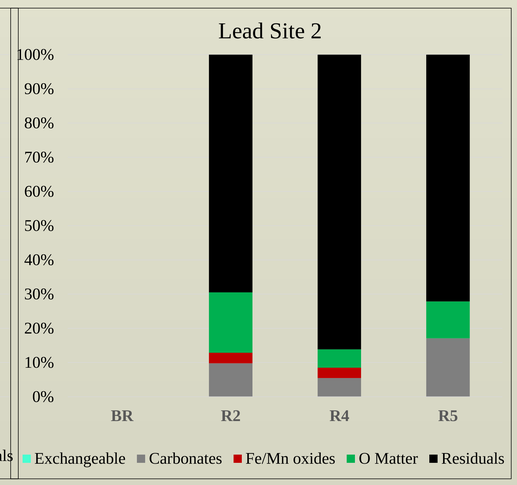
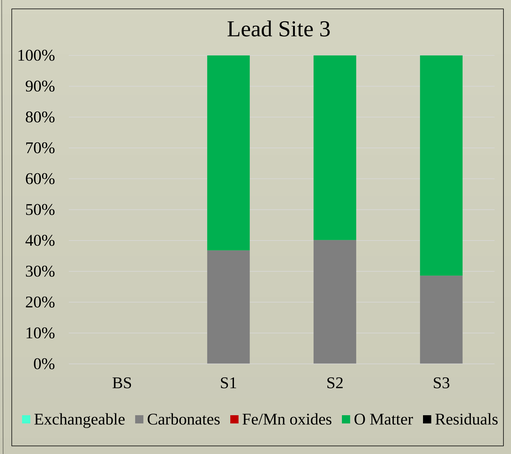


Figure 2: Partitioning of Mn according to Tessier sequential extraction scheme





Pb is less labile and is associated with the organic, residual and carbonate phases. Compared to the background samples that do not have lead, its presence is correlated to the organic waste amendments.



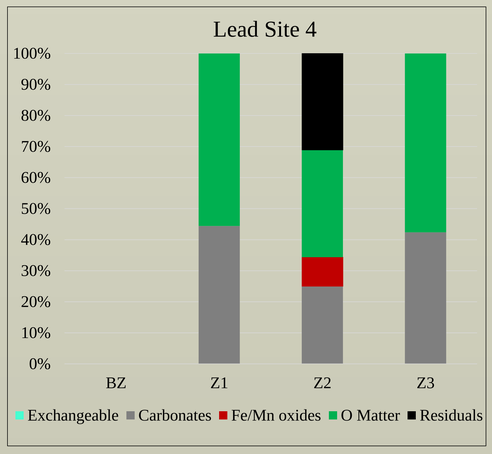


Figure 3: Partitioning of Pb according to Tessier sequential extraction scheme

DISCUSSION

The physico-chemical parameters are listed in Table 2. All samples were high in sand and the pH ranged from 5 to 8.6. Total organic carbon ranged from 0.6 to 1.8.

Analysis of compost samples showed elevated concentrations of all heavy metals. A general pattern of metals distribution in the organic, Fe-Mn oxide and carbonate fractions was shown, except in site 2 where metals were more concentrated in the residual phase accounting for a long term potential risk.

The absence of Pb and Ni in the background samples suggested that they were added in the soils with the organic compost amendments.

Sites	P.S	TOC	IC	pH	ZP	Mn	Pb	Cr	l Cu	Zn
BP	S	_	_	5.4	-14	7.88	0.00	0.34	0.03	0.54
P	S	1.8	0.02	5	-24	18.89	4.75	1.90	7.10	14.91
BR	SL	_	_	8.6	-15	7.88	0.00	0.34	0.03	0.54
R	SL	1.3	2.37	8.2	-24	46.70	5.31	5.02	0.31	12.07
BS	S	_	_	5.4	-14	7.88	0.00	0.34	0.03	0.54
S	S	0.6	0.03	7.5	-31	23.30	0.88	1.59	0.31	3.54
BZ	LS	_	_	5.4	-29	3.27	0.00	0.72	0.32	1.28
Z	LS	1.4	0	7.0	-30	9.58	2.70	2.42	1.13	4.63
CM	C	NA	NA	7.6	-44	66.43	6.30	2.56	32.05	64.75
SC	C	NA	NA	7.2	-41	99.21	5.00	6.40	20.09	38.42

Table 2: Soil & Compost Characterization metals (mg/kg)

CONCLUSION

This study assesses the distribution of 8 ETM in sandy soils under organic matter amendment in Senegal.

From the results, we can conclude that the concentration of metals increase with application of organic amendments. They were mostly associated with the organic and Fe-Mn oxides fractions.

Based on the US Regulatory limits (US EPA, 1993), heavy metal maximum concentrations in sludge (mg/kg) are 85 for Cd, 420 for Pb and 7500 for Zn. These values are far greater than those in our organic composts.

REFERENCE

Tessier, A., P., Campbell & M. Bisson, (1979). ″Sequential extraction procedure for the speciation of particulate trace metals,″ Analytical Chemistry, vol. 51, no. 7, pp. 844–851.

Dali-Youcef, N., Ouddane, B., & Z. Derriche, (2006). Adsorption of zinc on natural sediment of Tafna River (Algeria). Journal of Hazardous Materials, 1263-1270.

ACKNOWLEDGMENT

Funding for this work is provided by the project Feed the Future, USAID ERA.

I thank also the Senegalese Institute For Agronomic Research (ISRA) and Virginia Tech.