

Incorporation of composted sewage sludge in a maize farm, Portugal



The best agriculture management practice (AMP) selected was the use of composted sewage sludge from domestic wastewater treatment plant in maize farm. The investigated study site have been intensively used for more than 4 years under this AMP.

This AMP is based in the annual incorporation of 80 Mg ha⁻¹ of sewage sludge in the maize farm. The incorporation of sludge increases organic matter content that improves the soil structure and nutrients content.

Potential threats - soil contamination with Heavy metals

Soil contamination by heavy is a is a long term threat to the crop system and to the food chain due to the intensive use of sewage sludge. Although the sludge application improves physical and chemical soil properties, the longer-term application of sludge increase the heavy metal contents and other trace elements that may be phytotoxic, non-biodegradable and persistent in the environment .

It important to understand the behavior of those elements, including forms and availability in order to provide scientific information that support an effective management practices to mitigate soil contamination.

Results AMP vs. Control

Table 1- Heavy metal content in the soil of maize farms with AMP and control site, after harvesting in 2018 (n=3).

	Cd (mg/kg) (± SD)	Cr (mg/kg) (± SD)	Cu (mg/kg) (± SD)	Ni (mg/kg) (± SD)	Pb (mg/kg) (± SD)	Zn (mg/kg) (± SD)	pH (CaCl) (± SD)	pH (H ₂ O) (± SD)
AMP	0.8±0.0	47±3.4	120±0.5	16± 1.6	36±0.4	43±1.6	7 ±0.0	7±0.0
Control	0.4±0.0	38±2.7	78±2.2	23±1.1	35±1.0	37±2.1	6±0.0	8±0.0
Quality Standard*	3	200	100	75	300	300	—	—

5.5<pH<7

*Portuguese Decree-Law nº 276/2009

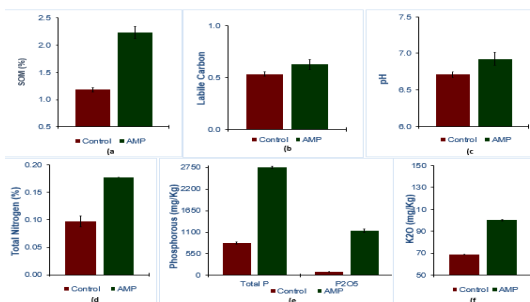


Fig. 1-Soil quality parameters analyzed after harvesting in 2018 in maize farms with sewage sludge, AMP, and farm managed with conventional agriculture practices. Control (n=3). a) Organic Matter Content (%), b) labile carbon, c) pH,, d) Total Kjeldhal nitrogen (%), e) Total phosphorus (P) and available phosphorus (P2O5), and f) available potassium (K2O).

- Results show a higher content of Cu in AMP than in the conventional farming. The Cu content of the soil with AMP is above the Portuguese Quality Standards (100 mg/kg).

-Maize field with sludge (AMP) shows higher content of Cd, Cr and Ni than in conventional farm (Control).

-The application of sewage sludge may represents a long term risk for soil contamination.

- Sewage sludge application improves the soil organic content (SOC) and the labile Carbon (LC). Labile carbon is the SOC fraction that is directly available for microbial activity, which can be a potential indicator of soil functions.

- Sludge incorporation also increase total nitrogen, total and available phosphorous, as well as the plant available potassium.

Results of visual soil quality assessment (VSA):

Table 2- VSA results in plots with AMP and control (meaning of the colors: Green- Good condition; yellow- Moderate condition and red- Poor condition).

General information	AMP	Control
Surface ponding	2	1
Susceptibility to wind and water erosion	2	2
Soil indicators		
Soil structure	2	1
Soil porosity	1	1
Topsoil compaction	1	1
Soil stability	2	2
Subsoil compaction	1	1
Number of clod development	2	2
Earthworm count	1	1
Degree of clod development	2	1
Soil colour	2	2
Labile organic carbon (LOC)	1	1
Score of soil indicators (average of soil indicators)	1.5	1.3
Plant indicators	AMP	Control
Crop yield	1	1
Size & development of the root system	1	1
Root diseases	2	2
Soil fauna	2	1
Environmental Exposure to Pesticides (EEP)	0	0
Score of plant indicators (average of plant indicators)	1.2	1.0
Total score (average of all indicators)	1.5	1.2

➤ The total score of VSA was higher in the AMP than Control study site. The sewage sludge incorporation seems to enhance some soil physical properties, such as the degree of clod development, the structure and soil consistency.

➤ AMP shows a better condition in plant indicators than the control. The impact of sewage sludge in improving SOC and LC may have favored plant development and soil fauna.

Study site location: Central region of Portugal



The study site are located in the central region of Portugal, Coimbra.

Pedoclimatic zone (D2.1) : Lusitanian zone

Topography: Fluvisols (2 % of slope) with a Loamy sand texture

Size of case study (ha, km²): 2 ha, 0.02 km²

Further details about the agriculture management practice (AMP)

The farm management in the selected study site is based on the annual application and incorporation of 80 Mg ha⁻¹ of composted sewage sludge from a domestic wastewater treatment plant. It also involves one tillage operation (0-35 cm deep) using a plower combined with two secondary tillage operations with a rotary power-harrow, per year.

The AMP also included a chemical weed control, in March/April, by using Lumax and Karate Zeon. Pesticides used in these study site contains S-metolachlor (herbicides), Atrazine (herbicides) and Lambda-cialotrina (insecticide) as active ingredients.



ISQAPER
Interactive Soil Quality Assessment

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