BIOCHAR POTENTIAL IN RECLAIMING DEGRADED SOILS

Paloma Campos¹, Ana Z. Miller², Heike Knicker¹, José María De la Rosa¹

1. Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC), Av. Reina Mercedes 10, 41012, Sevilla, Spain
2. HERCULES Laboratory, University of Évora, Évora, Portugal

pcampos@irnas.csic.es

toxic response on biota and humans

25th April 1998 (3:30 am)

- 4 millions m³ acidic water
- 2 millions m³ toxic mud

Geological map of the Iberian Pyrite Belt and metal deposits (Adapted from Espi et al., 2008).

a) Aerial view of the mine-tailing spill of Aznalcóllar (With permission from Greenpeace©); b) The flood reached at some points up to 3 meters high (Author: P. Arambarri).

The Aznalcóllar Mine Accident

Total surface affected: 4286 ha

400 m at both sides of the river

Mud: along 40 km down river

Water: along 60 km down river

Height of the muds from cms to 1.5 m

30 tons of dead fishes

Sludge
and dead
fauna
removal

Afforestation

Application
of
amendments

200 ha of soils still
contaminated with
trace elements

We propose:

**BIOCHAR AS AMENDMENT FOR TRACE ELEMENT
CONTAMINATED SOIL**

For its properties:

High C
content

High
porosity

Aromatic

High CEC

High pH

High
potential
stability

Present view of: a-b) remediated areas and c-d) spots without vegetation in the Guadiamar Green Corridor.

What is biochar?

Biochar (BC) is the carbonaceous solid residue produced through the thermochemical conversion (pyrolysis) of biomass under low O_2 atmosphere.

Field experiment. *In situ* remediation

Green Corridor of Guadamar (25 km north Seville, SW Spain)

2 soils (clay loam soil – Fluvisols):

MPS: Moderately Polluted Soil

HPS: High Polluted Soil

	WHC (%)	Bulk density (g/ml)	pH (CaCl ₂)	EC (μS/cm)	% C
HPS	32.73	1.1	3.62	3610	0.24
MPS	51.45	1.2	6.47	1809	0.29

MPS - Moderately Polluted Soil

HPS - Highly Polluted Soil

Sub-humid Mediterranean climate:

- Average temperatures: 9 °C in winter and 29 °C in summer.
- Irregular hydrological regime (summer droughts and flash floods during rainy periods).

Last year total precipitation: 403 L m⁻²

Amendments: biochar

Feedstock

Biochar production

Application of biochar to polluted soils

Biochar rate: 8 ton ha⁻¹

Rice
Husk
(RH)

Olive
Pit
(OP)

Continuously feed reactor

Pyreka reactor
Temperature: 500 °C
Time: 12 min
N₂ flux

Rotatory feeder

Burning pyrogas

Sample	pH		
	t ₆	t ₁₂	t ₂₀
C_HPS	3.57±0.13a	3.59±0.08a	3.52±0.20a
RHB_HPS	3.64±0.18a	3.68±0.21a	3.77±0.17a
OPB_HPS	3.63±0.03a	3.64±0.04a	3.69±0.17a
C_MPS	4.18±0.21a	4.8±0.10b	4.87±0.20b
RHB_MPS	4.75±0.01b	5.02±0.22b	5.07±0.18b
OPB_MPS	4.74±0.54b	4.86±0.50b	5.11±0.20b

Sample	Soil respiration (μmol CO ₂ m ⁻² s ⁻¹)		
	t ₆	t ₁₂	t ₂₀
C_HPS	1.0±0.2a	1.0±0.2a	0.9±0.2a
RHB_HPS	1.0±0.3a	0.8±0.2a	0.6±0.3a
OPB_HPS	1.2±0.4a	0.9±0.2a	1.2±0.6a
C_MPS	2.9±0.2b	1.2±0.8a	3.9±0.2b
RHB_MPS	2.7±0.3b	1.3±0.7a	3.3±0.4b
OPB_MPS	3.1±0.3b	0.5±0.1a	3.7±1.0b

□ pH and water holding capacity.

- Increases of soil pH at ≤10 cm for MPS at a very short term.
- No significant variations after one year.

□ Soil respiration

- MPS >> HPS.
- The difference is reduced with time (effects of climatic conditions on MPS).
- No significative differences between control and biochar amended soils.

Effects of biochar on native plant species

12 months

- ❑ MPS showed greater number of plant species than HPS.
- ❑ Biochar application enhanced vegetation cover
- ❑ Plant development (biomass production) and diversity was enhanced by biochar amendment.

NGS-based 16S rRNA gene analysis

Highly Polluted Soil | Moderately Polluted Soil

(6 meses)

(20 meses)

□ Biochar application increased bacterial diversity decreasing extremophiles

Conclusions

Some differences in soil properties, microbial population and plant diversity between MPS and HPS.

Differences were reduced with time and probably related with climate-seasonal effects.

After one year, 8 ton/ha of biochar was not enough to significantly change soil properties.

Biochar application modified the relative abundance of bacterial population in soils.

Further long-term analysis are required to investigate the effects of biochar on trace element polluted soil as the biochar continues to age (the experiment will continue for 2 years).

Thank you for your attention

Acknowledgements:

Grupo MOSS (IRNAS-CSIC)

MINEICO: CGL2016-76498-R and CGL2015-64811-P projects

Fundación Tatiana Pérez de Guzmán el Bueno

pcampos@irnas.csic.es

<http://www.bioremec.csic.es/>

<https://doi.org/10.1016/j.soilbio.2020.108014>