# Combined addition of biochar, bioactivators and plants as synergic strategy for the treatment of petroleum hydrocarbon-contaminated soil



Consiglio Nazionale

delle Ricerche

V. Mazzurco Miritana<sup>1</sup>, L. Passatore<sup>1</sup>, M. Zacchini<sup>1</sup>, F. Pietrini<sup>1</sup>, S. Carloni<sup>1</sup>, E. Peruzzi<sup>2</sup>, S. Marinari<sup>3</sup>, L. Massaccesi<sup>3</sup>, A. Barra Caracciolo<sup>4</sup>, P. Grenni<sup>4</sup>, L. Rolando<sup>4</sup>, <u>I. Nogues<sup>1</sup></u>



<sup>1</sup>Research Institute on Terrestrial Ecosystems, National Research Council (IRET-CNR) Via Salaria, km 29,300, 00015 Monterotondo Scalo, Rome, Italy <sup>2</sup>Research Institute on Terrestrial Ecosystems, National Research Council (IRET-CNR) via Moruzzi 1, 56124, Pisa, Italy <sup>3</sup>Department for Innovation in Biological, Agro-food and Forest systems DIBAF - University of Tuscia, Viterbo, Italy <sup>4</sup>Water Research Institute, National Research Council (IRSA-CNR) Via Salaria, km 29,300, 00015 Monterotondo Scalo, Rome, Italy *e-mail:isabel.nogues@cnr.it* 

- Biochar, a vegetal black carbon produced by the pyrolysis of biomass, is receiving much attention in recent times for soil remediation due to its physicochemical characteristics:
  - -The surface area and the adsorption capacity of the pore structure make biochar suitable for the immobilization of toxic compounds.
  - -The pores and particles of biochar may provide a niche for the growth and reproduction of microorganisms and may function as a microbial carrier.
- The use of biochar in synergy with other biological techniques aimed to enhance microbial activity, such as rhizoremediation and bioaugmentation, can represent a powerful strategy to accelerate the removal of organic pollutants from soil.

OBJECTIVE: Evaluation of the microbial community structure of a petroleum hydrocarbon (PH)- contaminated soil following the addition of biochar and biochar plus bioactivators, in the presence or not of plants.





## Main characteristics of biochars and soil

PARAMETER	<b>BIOCHAR OLIVE</b>	<b>BIOCHAR HALZENUT</b>	SOIL
Granulometry			
>5.0 mm (%)	14.4	2.7	
5.0-2.0 mm (%)	78.4	50.3	
2.0-0.5 mm (%)	6.7	28.7	
<0.2 mm (%)	0.6	18.3	
рН	11.6	10.7	6.4
EC (mS/cm)	13160	12710	
Ash (%)	13.7	33.8	
H/C	0.10	0.10	
Organic carbon (%)	73.82	58.45	12.5
Total N (%)	0.2	0.3	0.25
P (mg/kg)	760	150	380
K (mg/kg)	20000	34000	1200
Hydrocarbons (C10-			
C40) mg/kg			10.100
SOIL TEXTURE			
Sand (%)			80
Silt (%)			11.3
Loam (%)			8.7
Soil USDA class			SF



0.5 % (w/w) Bacterial-fungal consortium able to degrade PHs



Greenhouse conditions

The microbial community structure in terms of total microbial abundance and cell viability in the treated soils was evaluated at 0 days, by LIVE-DEAD (Live cells %) and DAPI staining (N. Tot cells /g soil).

# **RESULTS AND DISCUSSION**

Notwithstanding the high soil PHs concentration, significantly higher than the limit established for agricultural areas by Italian legislation (hydrocarbons C10-C40 = 50 mg/kg; DM 46 /2019), the microbial community presented remarkable values of total microbial abundance (1.95 x 10<sup>8</sup> - 2.44 x 10<sup>8</sup> N. total cells/g soil) and of cell viability (around 40%) for all experimental conditions.

The bioactivators added to the soil showed a total microbial abundance

**Bioactivators** 



### Main characteristics of treated soils

			<b>BIOCHAR +</b>
PARAMETER	CONTROL	BIOCHAR	BIOACTIVATORS
рН	5.5	7.4	6.8
TOC (%)	5.14	5.55	2.24
TN (%)	0.05	0.05	0.09
P (mg/Kg)	34.40	36.44	52.06
K (mg/Kg)	105.61	2372.09	544.06
Ca (mg/Kg)	851.36	1495.22	1218.46
Mg (mg/Kg)	104.7	210.84	143.21
Na (mg/Kg)	28.07	337.77	333.13



Acknowledgements: The present study in the framework of BIOCHAR LATIUM Project, CUP J85F21000410002 has been funded by Lazio Region within POR FESR Lazio 2014-2020 programme. We also thank Milano -Bicocca University and Eurovix for providing us with the contaminated soil and bioactivators, respectively.

BB

C-P

B-P

BB-P

estimated by DAPI staining of  $4.38 \times 10^{10} \pm 8.02 \times 10^{8}$ N. total cells/g. In this microbial consortium the Fungi were half the number of bacteria and the cell viability resulted to be 46%.



# CONCLUSIONS

Preliminary results evidenced that, despite the high PH contamination, the agricultural soil affected by an oil spill maintained an abundant and vital microbial community.

Biochar, bioactivator and plant addition to soil are expected to improve the microorganism activity in order to increase the

**Siochar Latium** 

https://www.biocharlatium.eu





