Biochar Latium

Valorizzazione del biochar prodotto dal recupero di materiali legnosi di scarto derivanti da filiere del Lazio

Biochar Latium

Progetto Biochar Latium
Conferenza conclusiva

15 marzo 2023

Il progetto EIT FOOD - Black to the Future: effetti sul suolo di diversi trattamenti ammendanti

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Consiglio Nazionale delle Ricerche

REGIONE LAZIO

PROGETTO COFINANZIATO DALL'UNIONE EUROPEA - POR FESR 2014-2020

Black To the Future (BTF) is a innovation project, co-funded by the European Institute of Innovation and Technology (EIT), European Union, to **develop and test an advanced mixture of biochar and compost called "CBmix"** with the goal to reduce soil degradation, increase carbon capture and plant yield improvement within a circular economy network.

CAVIRO

enomondo

CRPV soc. coop. CENTRO RICERCHE PRODUZIONI VEGETALI

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

Cyprus University of Technology

CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

URBAN CROP SOLUTIONS

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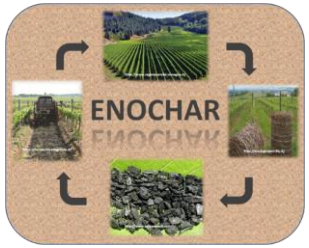
https://blacktothefuture.eu/

Introduction

- Need to reduce GHGs
- Soils are loosing SOM
- Increasing price of fertilizers
- Biomasses as amendments
- Increase of carbon stock
- Circular economy principles
- Trials in Tebano (RA)

From ENOCHAR to BLACK TO THE FUTURE to PSR 2014-2020



Production of the matrices and their distribution in the field

3° Year distribution of the matrices

4° Year distribution of the matrices

5° Year distribution of the matrices

2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024

A self financed project on circular economy and carbon stock in vineyards

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BLACK TO THE FUTURE

Biochar and compost as soil amendment

Programma di Sviluppo Rurale dell'Emilia-Romagna 2014-2020

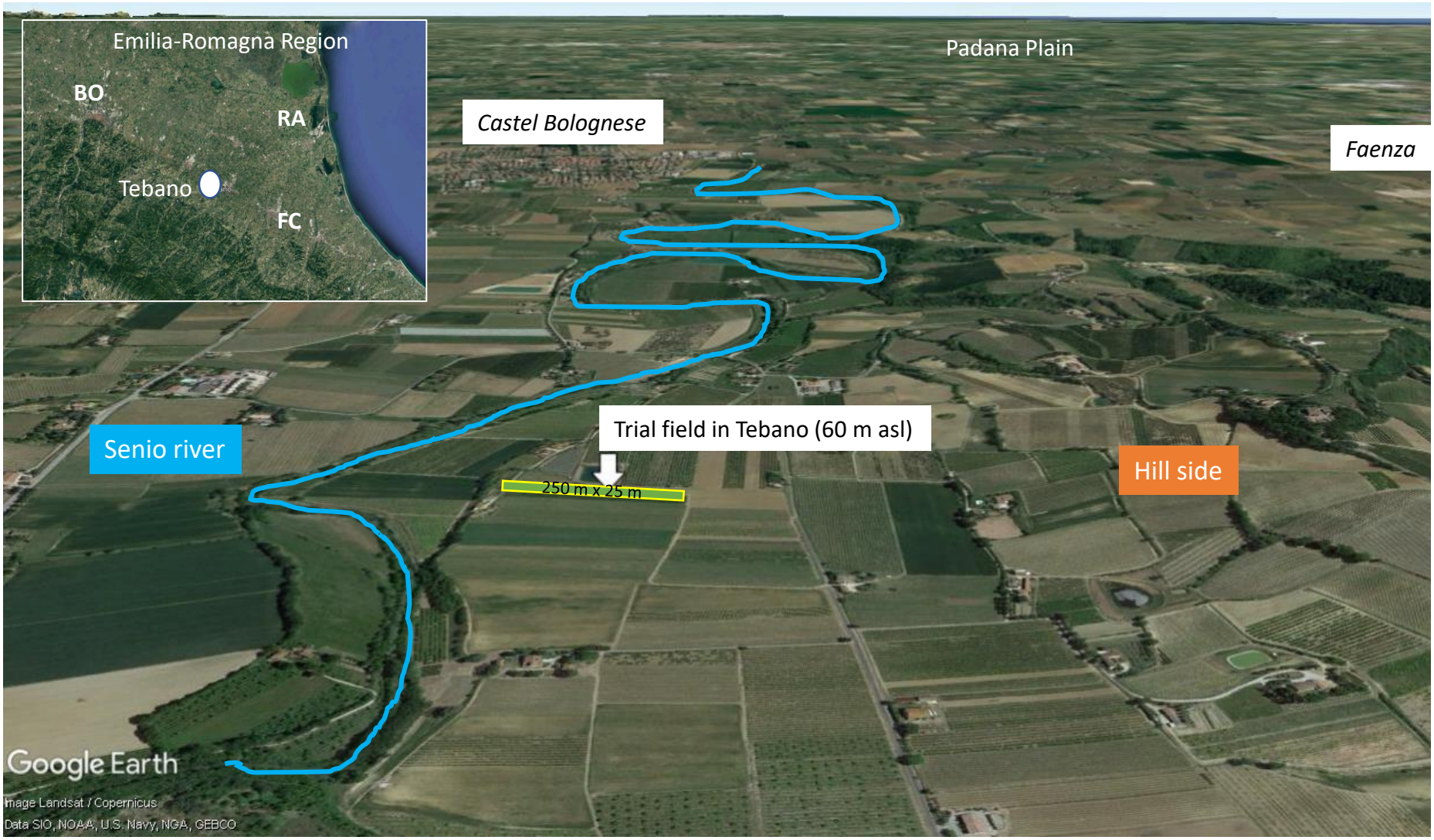
Soil analysis T = 0

Soil analysis T = 3

Soil analysis T = 4

Soil analysis T = 5

The trial site



The soils of the trial field have some differences because of their morphological position and age

Younger soil, less leached

Haplic Calcisols
(WRB, 2007)

Older soil, more leached

Fluvic Cambisols (Colluvic)
(WRB, 2007)

- Slightly coarser texture (S 42%; L 40%; A 18%)
- Presence of lime ($CaCO_3$ 6%)
- Sub-alkaline pH (8.11)
- Low OM (1.43%) and Ntot (0.098%)

- Slightly finer texture (S 31%; L 47%; A 22%)
- Absence of lime ($CaCO_3$ 0%)
- Neutral pH (7.14)
- Low OM (1.65%) and Ntot (0.112%)

Analysis at T=0 (Oct. 2018) by Cicognani Labs.

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The tested amendment (average values)



Parameters	Units	Compost (ACFA)	Biochar	CBmix (10:3)
Moisture (105°)	%	30	20	39
pH (1:10)		7.4	10.01	7.6
C tot	% s.s.	30	73.4	34
N tot	% s.s.	2.5	1.13	2
C/N ratio		12	65	24
EC (1:10)	mS/cm	2.5	3.4	2.8
P tot (as P_2O_5)	% s.s.	6.9	0.50	2.4
K tot (as K_2O)	% s.s.	1.4	2.28	2.5

(Analysis from EMC Innovation Lab and CSA Lab)

Treatments

The **BTF project** involves 4 theses replicated 3 times, for a total of 12 plots.

Each plot consist of 15 plants and is 15 m long.

Treatment	Quantity t/ha (d.m.)	Plots
BIOCHAR	**20**	1-2-3
CBmix	**10** Compost + **3** Biochar	4-5-6
COMPOST	**10**	7-8-9
NOT TREATED	-	10-11-12

Fertilization with ternary compound fertilizer (12-8-16) at a dose of 30 units N, 20 units P and 40 units K.

BTF project - Trial field and plots distribution in the randomized-block design.

Cultivar: SAUVIGNON KRETOS

Trellis system: GUYOT (2.6 m x 1.0 m)

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Soil sampling on 25/08/2021 and 29/08/2022

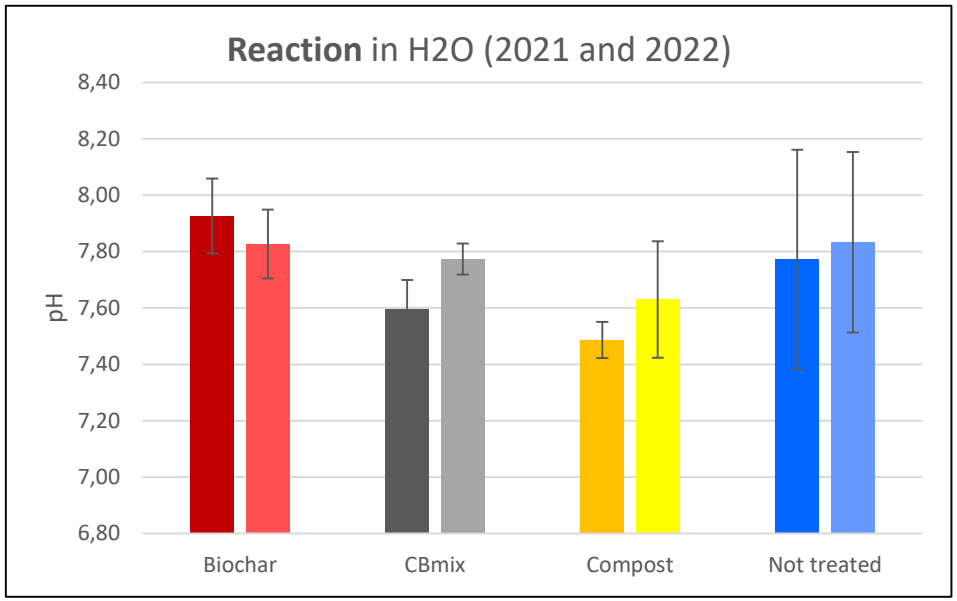
In each of the 12 plots, 5-6 sub-samples were collected by means of an auger, to a depth of 40 cm.

The bulk material was homogenized and quartered.

Chemical analysis

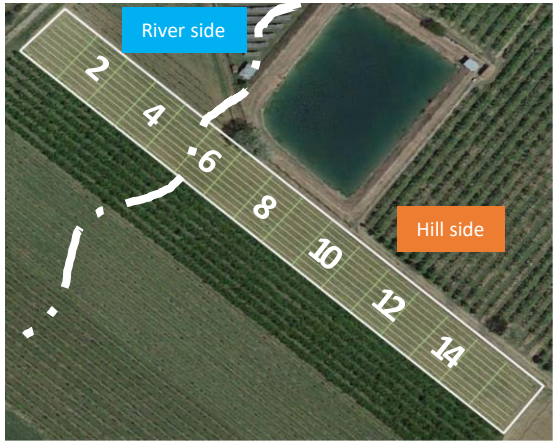
1 : **pH** in water soil suspension with soil:water ratio = 1:2.5
2 : **Total lime** by volumetric method
3 : **Electrical Conductivity** in water soil suspension with soil:water ratio = 1:2.5
4 : **Total Organic Carbon** by Elemental Analyzer
5 : **Total Nitrogen** by Elemental Analyzer
6 : **Available P** (Olsen method)
7 : **Cation Exchange Capacity** ($BaCl_2$ solution buffered at pH 8.2)
8 : **Exchangeable** Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} (ICP-OES)
9 : **Soluble cations** Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} (ICP-OES)
10: **Soluble anions** HCO_3^-, Cl^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, F^-, Br^- by ionic chromatography (IC)

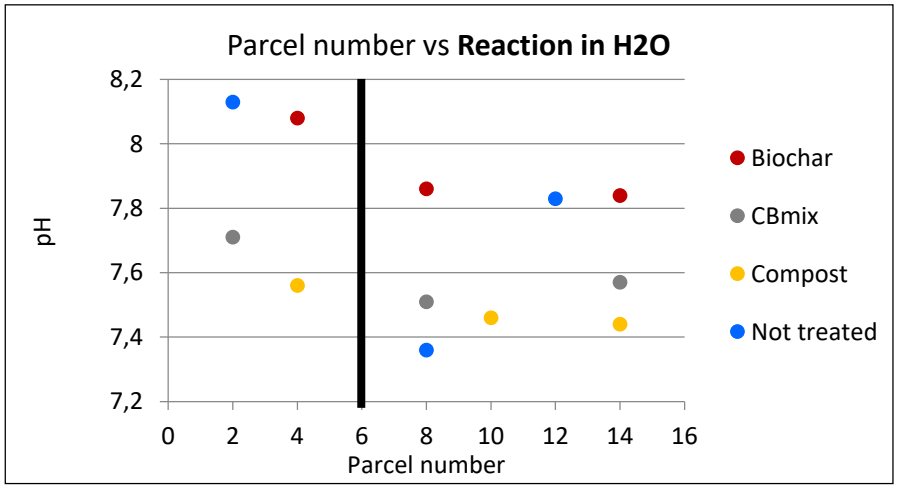
Results

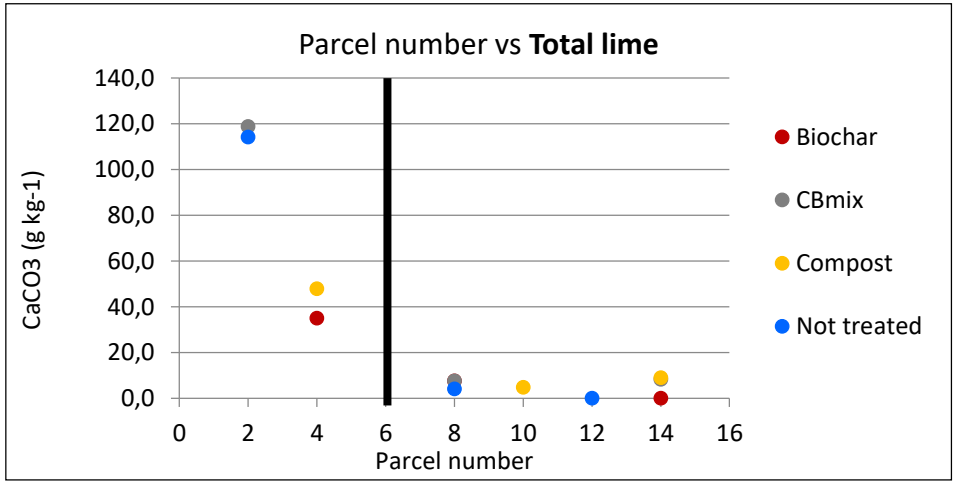


- **Biochar** slightly increases the pH
- **CBmix** and **Compost** slightly decrease the pH
- **Large variability**
- Influence of soil diversity

Parcel number







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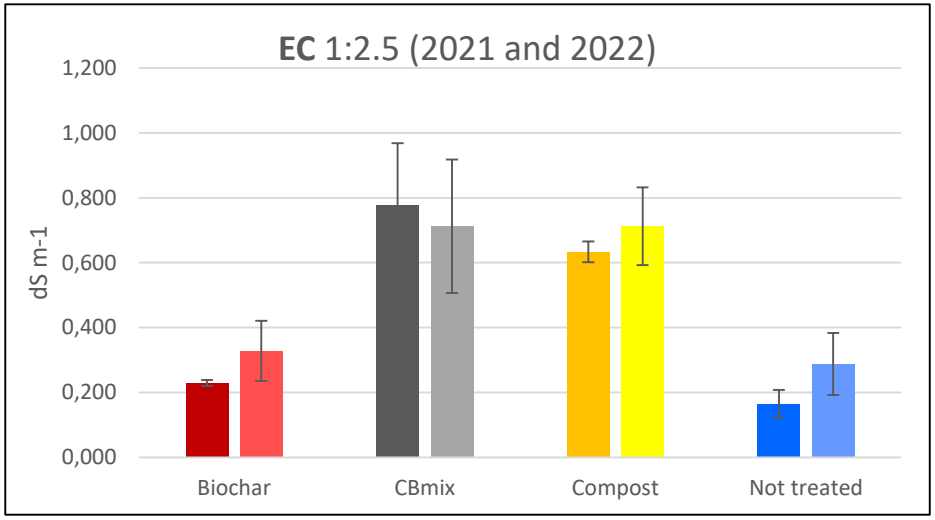
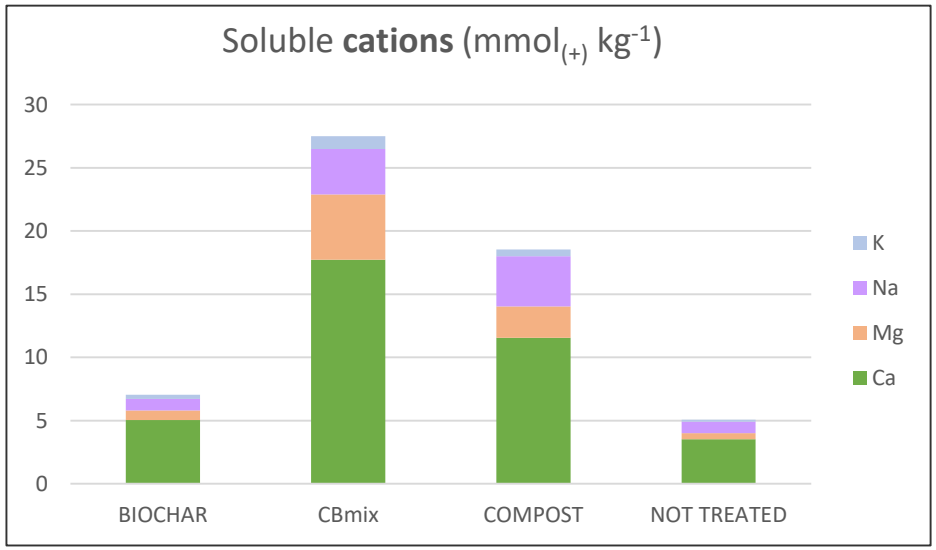
Results

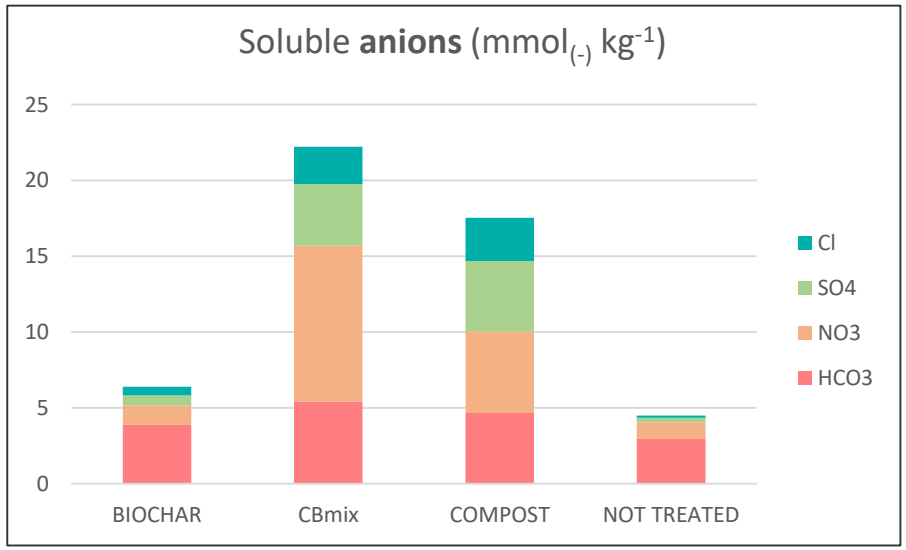


- **CBmix** and **Compost** slightly increase the EC
- **Biochar** has no effect

- **CBmix** and **Compost** increase cations soluble forms
- **Biochar** has little effect

- **CBmix** and **Compost** increase anions soluble forms
- **Biochar** has little effect





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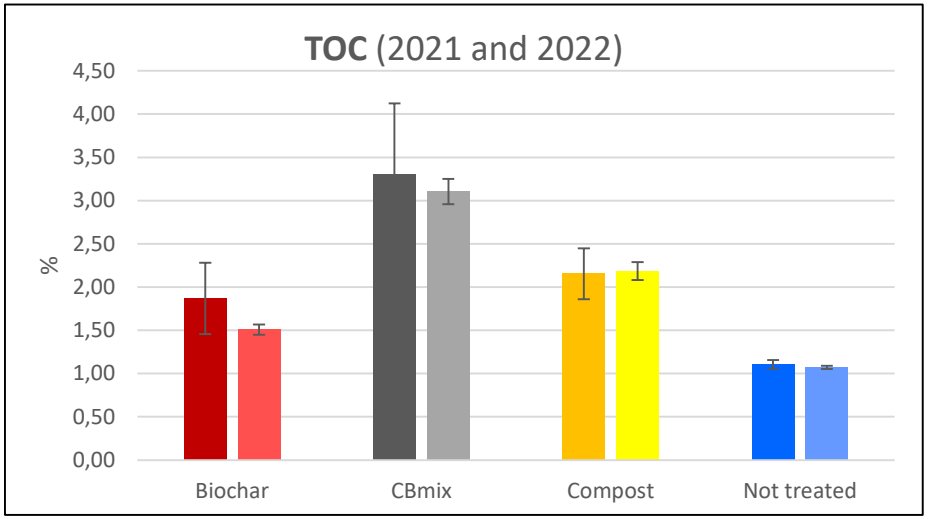
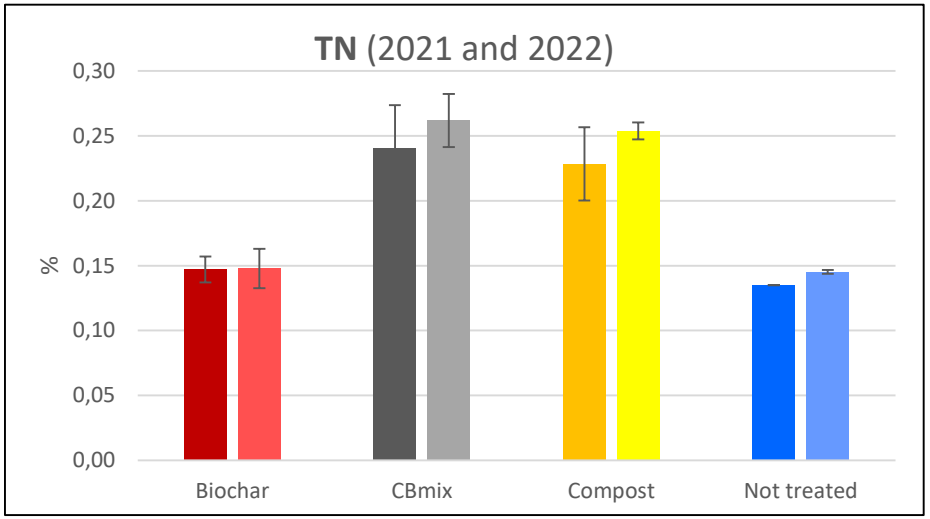
Results



- **CBmix** significantly increases the TOC (approx. 3x)
- **Compost** significantly increases the TOC (approx. 2x)
- **Biochar** increases the TOC



- **CBmix** and **Compost** significantly increase the TN (approx. 2x)
- **Biochar** has no effect on the TN

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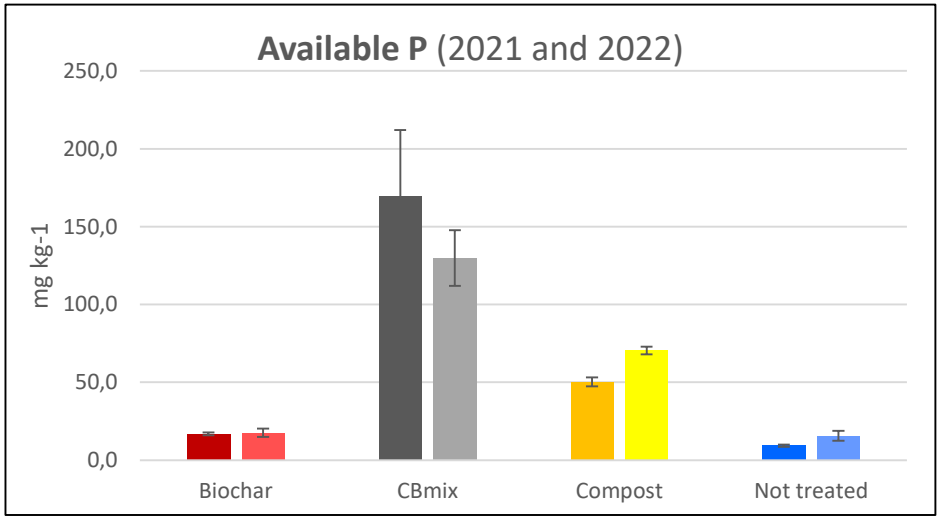
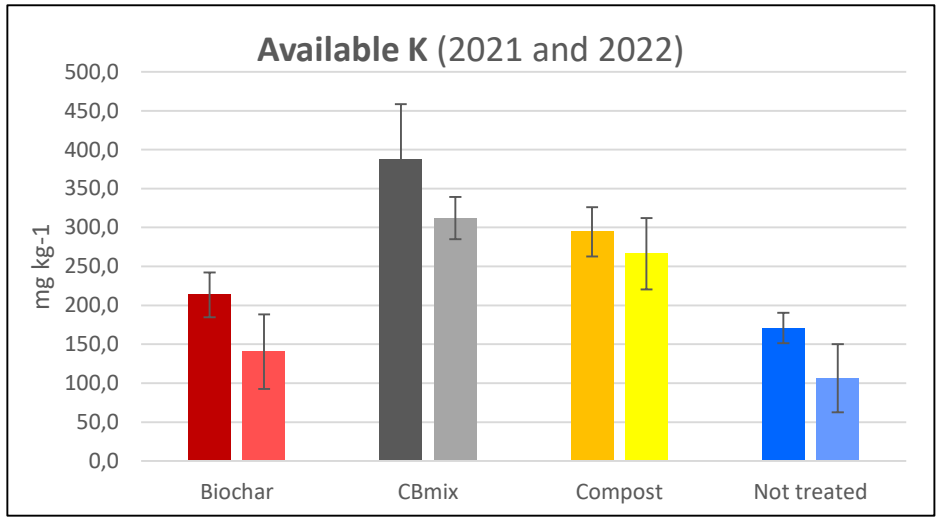
Results



- **CBmix** significantly increases the available P (approx. 17x) but with large SD
- **Compost** increases the available P (approx. x5)
- **Biochar** has little effect on the available P



- **CBmix** significantly increases the available K (approx. 2x)
- **Compost** and **Biochar** increase the available K

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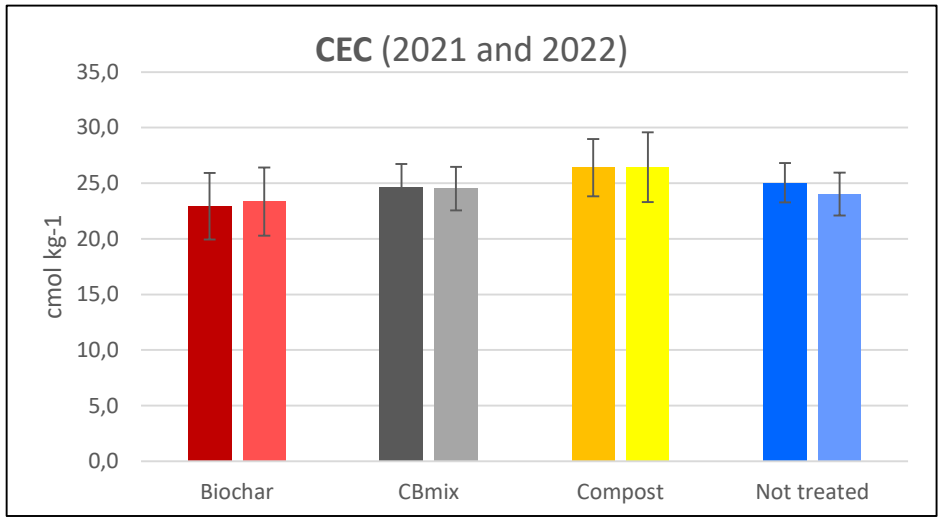
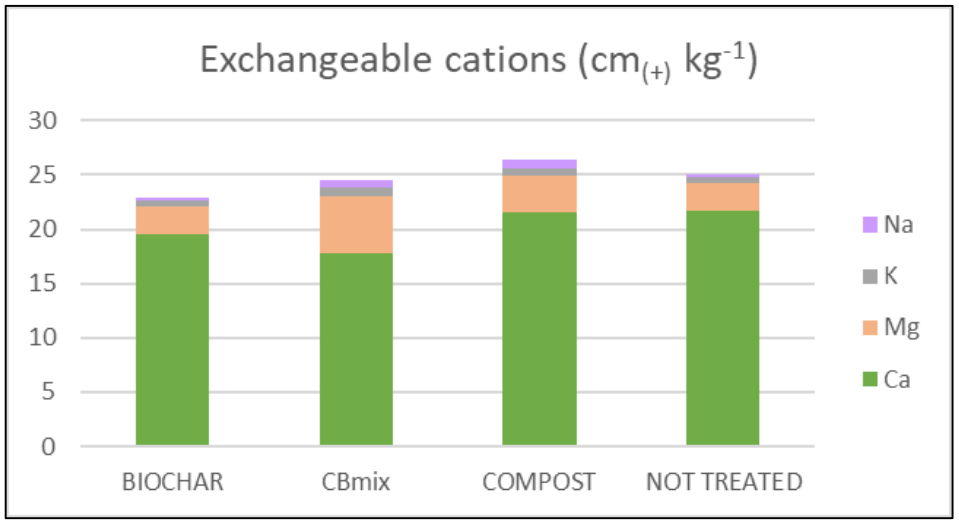
Results



- All treatments effect moderately the CSC
- **Biochar** slightly decreases CEC
- There is also a slight effect linked to soil (i.e., SOM, texture)



- Cation aboundance is, for all treatments, Ca > Mg > K > Na except for Compost in which Na > K

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Summary of results

									Soluble bases				Soluble anions			
Treatment	**pH**	**EC**	**Lime**	**TOC**	**TN**	**P avail**	**K avail**	**CEC**	**Ca^{2+}**	**Mg^{2+}**	**K^{+}**	**Na^{+}**	**HCO_3^-**	**Cl^-**	**NO_3^-**	**SO_4^{2-}**
COMPOST	-	+	-	++	+	++	++	+	++	++	++	++	++	++	+	++
BIOCHAR	+	-	--	+	/	+	+	-	+	+	+	/	+	+	/	+
CBmix	-	+	+	+++	+	+++	+++	-	++	++	+++	++	++	++	++	++

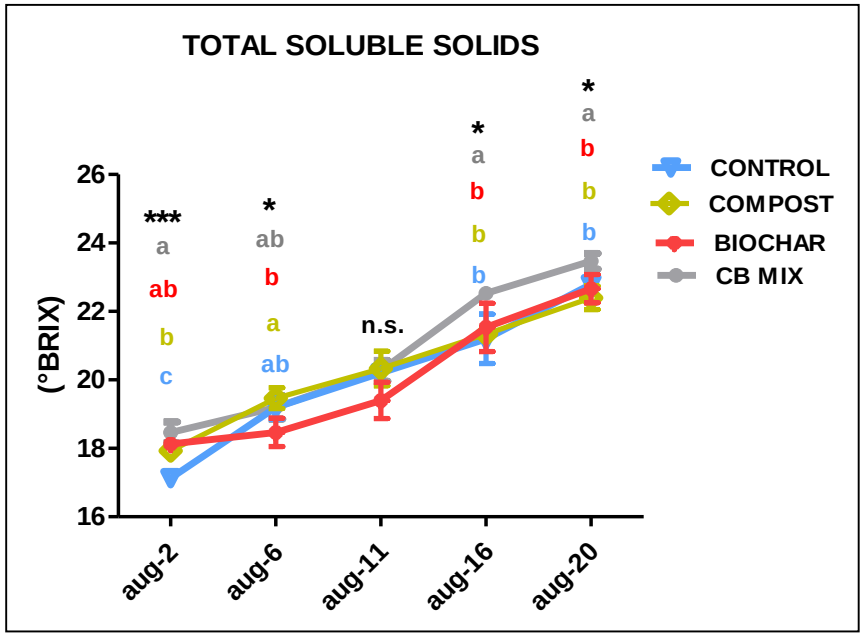
Large SD, soil influence

LEGEND	MEANING
+ → +++	**Progressive increase** (in respect to NOT TREATED)
- → - - -	**Progressive decrease** (in respect to NOT TREATED)
/	No effect

- **All treatments increase TOC, TN, P, K** content with the order **CBmix** > **Compost** > **Biochar**
- Results regarding pH, lime and CEC are partially effected by soil characteristics

Productive parameters at harvest

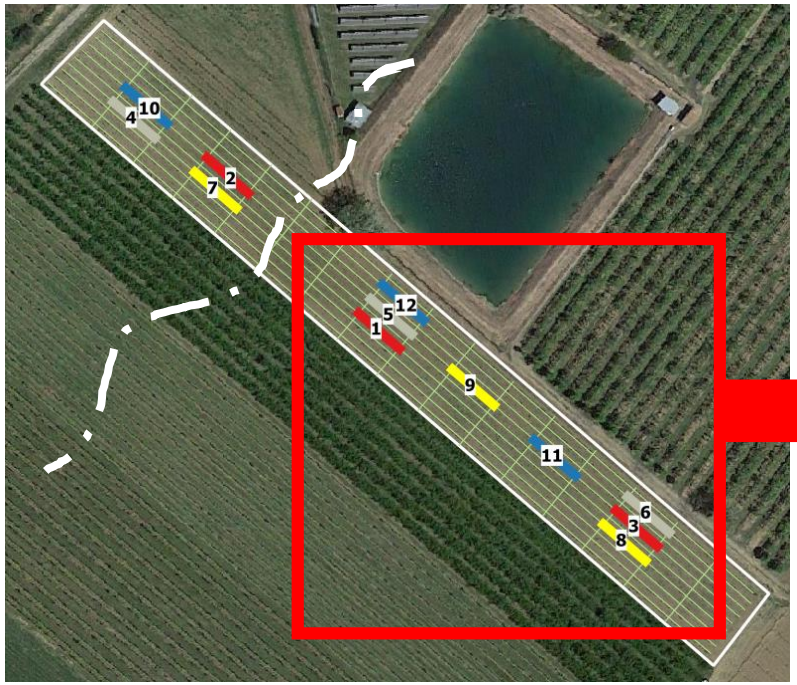
THESIS	BUNCH (N)	BUNCH WEIGHT (g)	PRODUCTI-VITY (kg/plant)
CONTROL	19	152	2.88
COMPOST	18	164	**2.93**
BIOCHAR	19	156	**3.01**
CB MIX	19	169	**3.13**



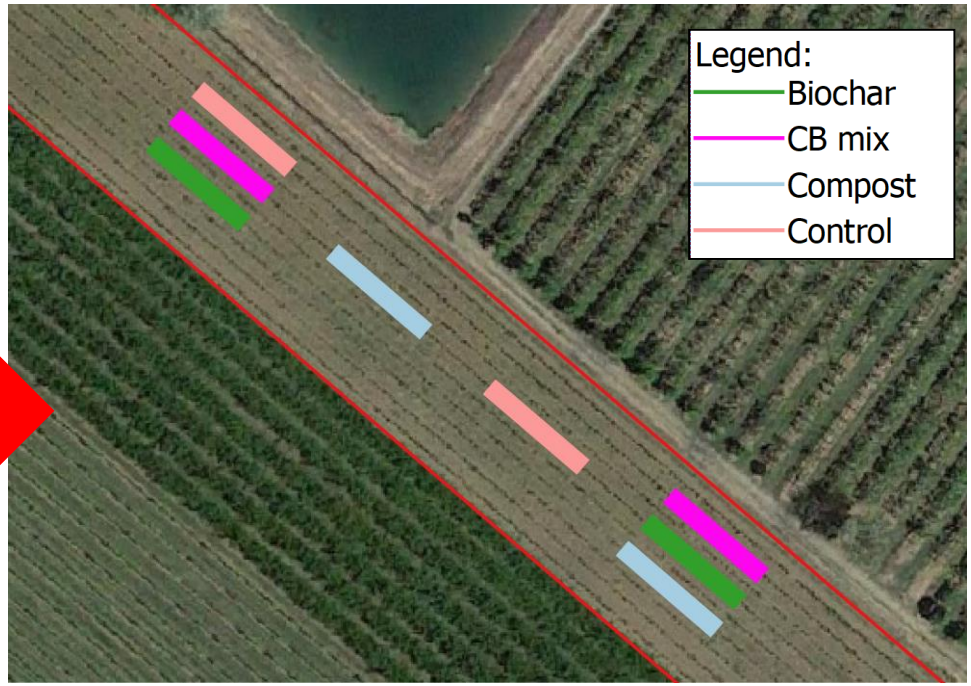
- All thesis performed better than control.
- The **CB MIX** Thesis presented the largest values of Total Soluble Solids and productivity.

Evaluation of the Soil Biological Quality (QBS-ar)
based on the adaptation of microarthropods to life in soil (Parisi, 2001)

BTF trial field and plots distribution



QBS trial field and plots distribution



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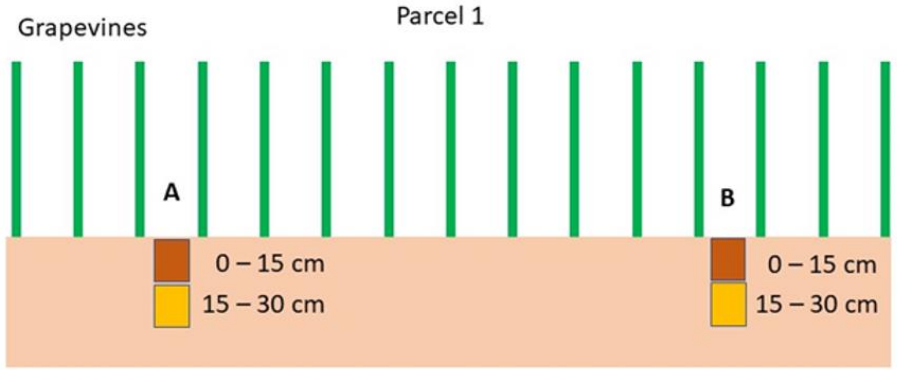
Sampling strategy



4 theses

↓

2 replications for each thesis

↓

8 plots

↓

2 locations in each plot

↓

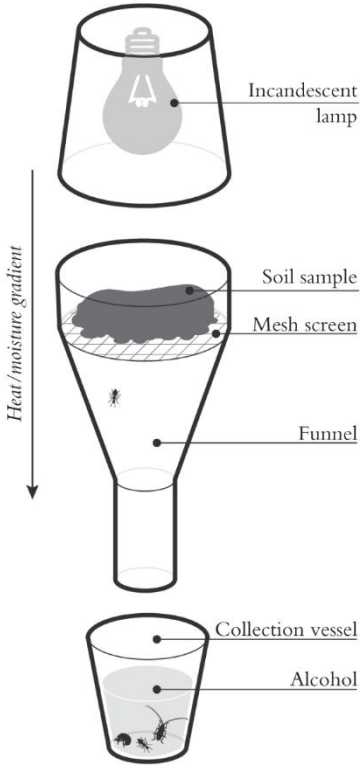
2 depths

↓

32 soil samples

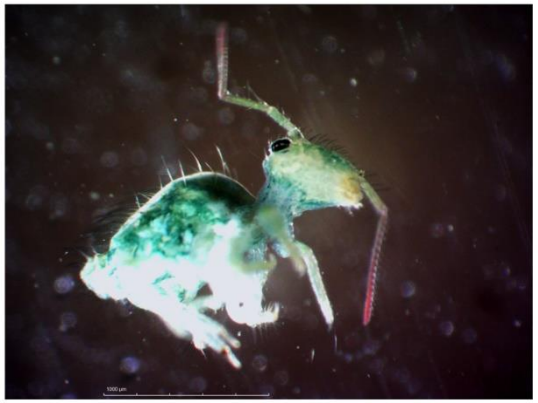
Estraction

Berlese-Tullgren extraction method



Recognition, classification and counting of soil microarthropods

Ex.:Collembola



Poorly adapted to life in the soil

Well adapted to life in the soil

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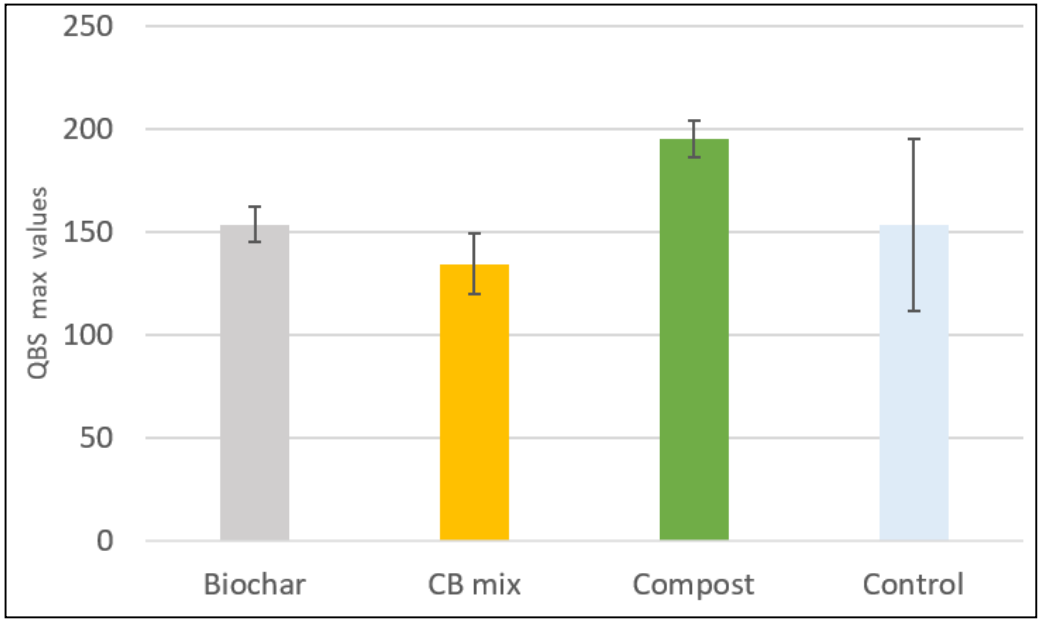
Soil Biological Quality – microarthropods (QBS-ar)

QBS-ar max



QBS-ar max value	Soil Quality
QBS<50	Very bad
50< QBS< 100	Poor
100< QBS< 150	Fair
150< QBS< 200	Good
QBS> 200	Excellent

- All tested biomasses did not alter significantly microarthropods presence
- Little differences between surficial and deep soil samples
- CB mix results in lower QBS than the other tests, albeit fair

Characterization of the soil microbiota after compost and biochar addition: composition of bacteria and fungal communities (Prof.ssa M. Cappelletti)

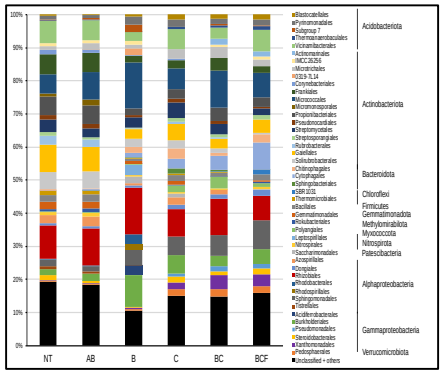
DNA extraction from soil samples (collected on July 2021)

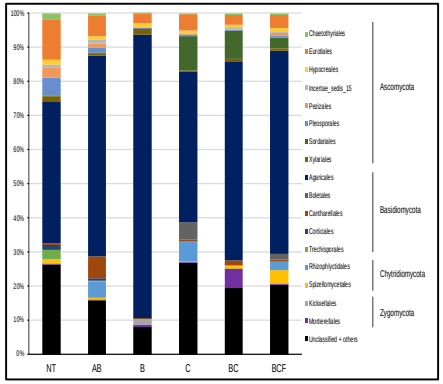
Polymerase Chain Reaction

PCR amplifcation of 16S rRNA gene (Bacteria) and ITS region (Fungi)

Illumina sequencing

Bacterial community





Fungal community

Samples	Description
NT	**Not treated** soil
B-22	**Soil treated with Biochar**
b-B22	**Biochar** extracted from soil B-22
acm-10	**Soil treated with Compost**
CBmix	Soil treated with **Mature** Compost + Biochar (30%)
BCf	Soil treated with **Fresh** Compost + Biochar (30%)

amendment every year

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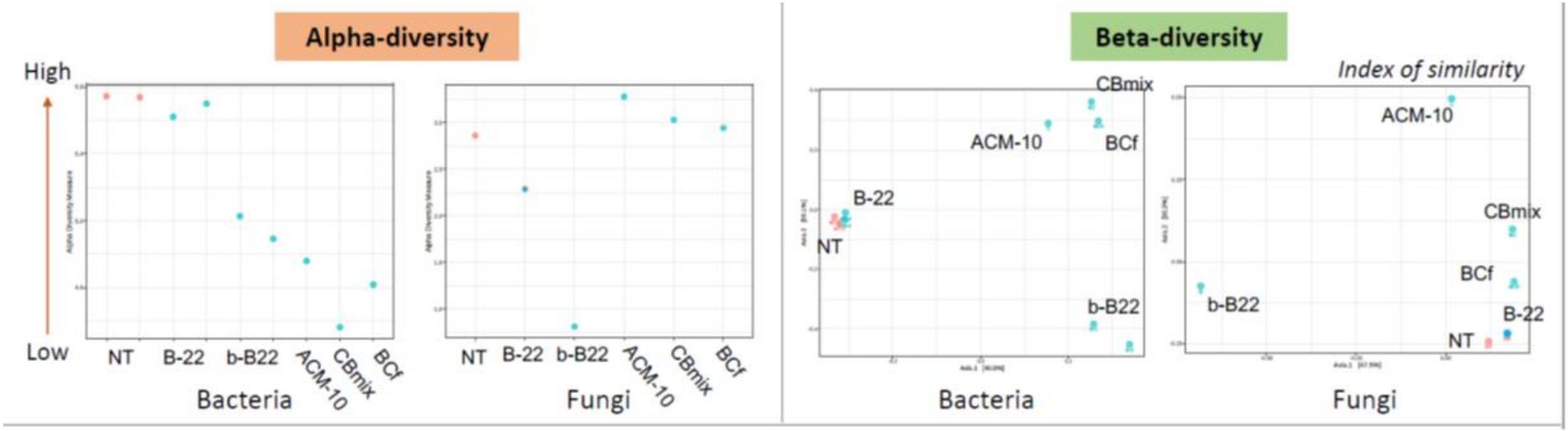
Results



- Addition of **compost** (both mature and fresh):
  - DECREASES the **bacterial diversity** and INCREASES the **fungal diversity** in soils
  - STRONGLY INFLUENCES the bacterial and fungal **community composition** (C, BC and BCF ≠ NT)
- Addition of **biochar** does not strongly influence the diversity and composition of microbial community in soils (as compared to compost) (both fungi and bacteria)
- Microbial community adhered on the **only biochar** (b-B22) significantly differs from all the other samples

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Conclusions

Soil

- All treatments increase TOC, TN, P, K, EC with the order **CBmix** > **Compost** > **Biochar**
- Some differences seem linked to soil charateristics

Grape

- All treatments increase total soluble solids and productivity

QBS-ar

- All tested biomasses did not alter significantly microarthropods presence
- CBmix results in lower QBS than the other tests, albeit fair

Soil microbiota

- **Compost** strongly influences the bacterial and fungal **diversity** and **community composition**
- **Biochar** does not strongly influence the diversity and composition of microbial community

The future

- There is a need of long term experiment because changes in soil properties are slow (Long Term Experiment Platform – LTPE)
- A RER rural development program (PSR) project has been financed to continue the experiment
- QBS-ar will performed again
- A model for Carbon turnover (ROTHAMSTED CARBON MODEL - RothC) will be applied
- LCA analysis will be also performed
- Study on aged biochar are on going
- Study on functionalization of biochar (magnetic) for different purposes
- Study on the remediation of polluted soil

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