
# Application of biochar and compost on Camelina crops in semi-arid land: effects on feedstock production and soil health

RE·CORD

**Prepared by**
**Tommaso Barsali**
**Francesca Tozzi**

**23th February 2023**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 789562.

# RED II Esca factor Carbon stock calculation

# REDII Esca factor calculation – Carbon Stock

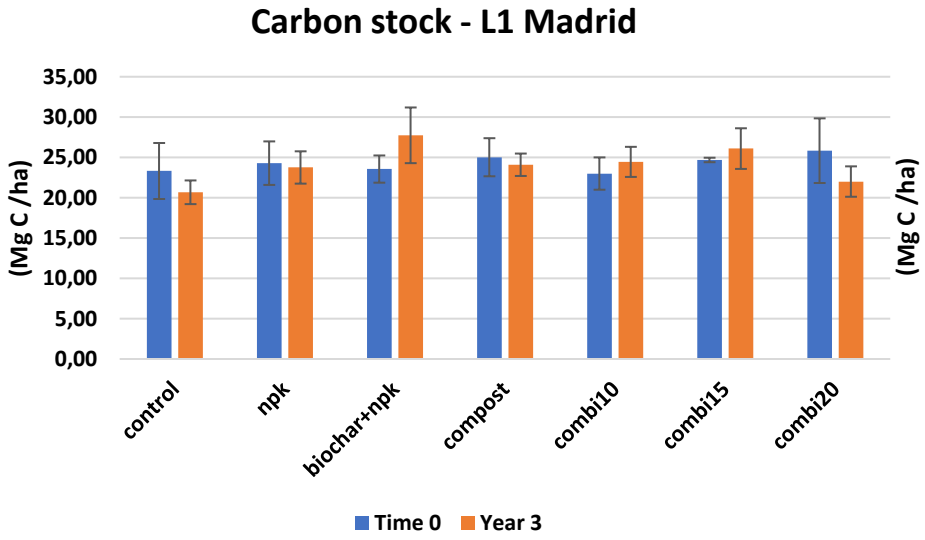
Economic operators seeking to claim emission savings from soil carbon accumulation via improved agricultural management ($\mathbf{e_{sca}}$) in terms of g $CO_2$eq/MJ should use the following formula to calculate their actual values:

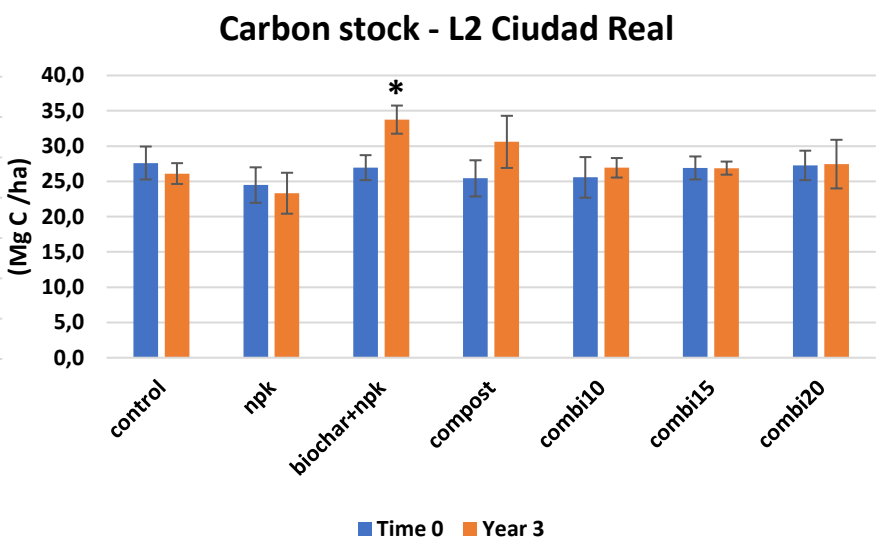
$$e_{sca} = (CS_A - CS_R) \times 3{,}664 \times 10^6 \times \frac{1}{n} \times \frac{1}{P} \text{-} e_f$$

Where:

| | |
|---|---|
| $CS_R$ | is the mass of soil carbon stock per unit area associated with the reference crop management practice in Mg of C per ha. |
| $CS_A$ | is the mass of soil estimated carbon stock per unit area associated with the actual crop management practices after at least 10 years of application in Mg of C per ha. |
| 3,664 | is the quotient obtained by dividing the molecular weight of $CO_2$ (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) in g $CO_{2eq}$/g C. |
| *n* | is the period (in years) of the cultivation of the crop considered. |
| *P* | is the productivity of the crop (measured as MJ biofuel or bioliquid energy per ha per year). |
| ef | emissions from the increased fertilisers or herbicide use |

# REDII Esca factor – Carbon Stock calculation




$$CS_R = \frac{\left(C_{ORG}\ x\ BD\ x\ T\ x(1-F)\right)}{100}$$

$$CS_{Adjusted} = \left(\frac{BD_O}{BD_N}\right)\ x\ CS_n$$

Where:

$CS_R$ is the carbon stock at the initial measurement expressed as Mg of C/ha;

$C_{org}$ is the organic carbon content (g C/ha);

BD is the soil bulk density (kg/m$^3$);

T is the thickness (depth, m);

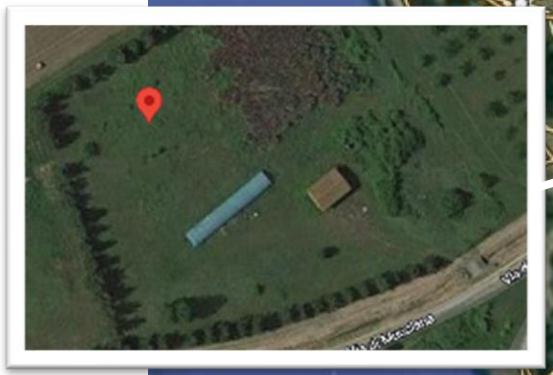
F is the volume of coarse mineral fraction in % by mass (m$^3$/m$^3$ x 100).

# REDII Esca factor calculation
# Carbon Stock

| LOCATION 1 | | | | | | |
|---|---|---|---|---|---|---|
| Madrid | Stock (Mg of C /ha) | | SD | | | |
| Treatment | Time 0 | Year 3 | Time 0 | Year 3 | Delta | C stock increment (%) |
| control | 23.33 | 20.69 | 3.5 | 1.5 | -2.6 | -11.3 |
| npk | 24.3 | 23.8 | 2.7 | 2.0 | -0.5 | -2.2 |
| biochar+npk | 23.6 | 27.8 | 1.7 | 3.5 | 4.2 | 17.8 |
| compost | 25.0 | 24.1 | 2.4 | 1.4 | -0.9 | -3.7 |
| combi10 | 23.0 | 24.4 | 2.0 | 1.9 | 1.4 | 6.3 |
| combi15 | 24.7 | 26.1 | 0.3 | 2.5 | 1.4 | 5.8 |
| combi20 | 25.8 | 22.0 | 4.0 | 1.9 | -3.8 | -14.8 |
| **LOCATION 2** | | | | | | |
| Ciudad Real | Stock (Mg of C /ha) | | SD | | | |
| Treatment | Time 0 | Year 3 | Time 0 | Year 3 | Delta | C stock increment (%) |
| control | 27.6 | 26.1 | 2.3 | 1.5 | -1.5 | -5.4 |
| npk | 24.5 | 23.3 | 2.5 | 2.9 | -1.2 | -4.8 |
| biochar+npk | 26.9 | 33.7 | 1.8 | 2.0 | 6.8 | 25.3 |
| compost | 25.4 | 30.6 | 2.6 | 3.7 | 5.2 | 20.3 |
| combi10 | 25.6 | 26.9 | 2.9 | 1.4 | 1.4 | 5.3 |
| combi15 | 26.9 | 26.9 | 1.6 | 0.9 | 0.0 | -0.2 |
| combi20 | 27.3 | 27.4 | 2.1 | 3.4 | 0.2 | 0.7 |

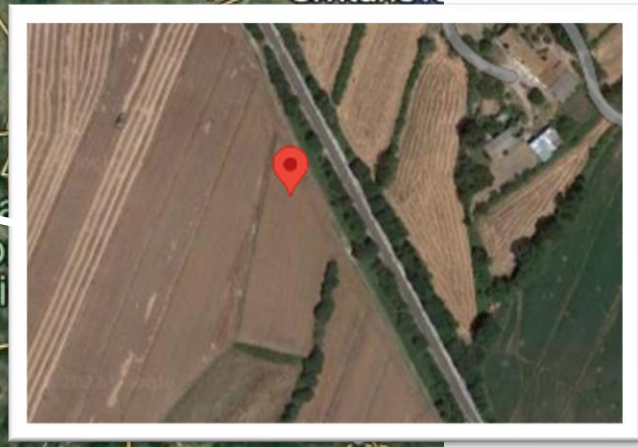
# Italian field trials in Montepaldi and Terontola

# Italian field trials



MONTEPALDI

TERONTOLA



# Italian field trials

## RESEARCH GOAL

Evaluation of the effect of biochar alone or mixed with compost on:

- Camelina seed yield, biomass and oil yield and quality
- Soil chemical and physical properties
- Agronomic Use Efficiency of nitrogen

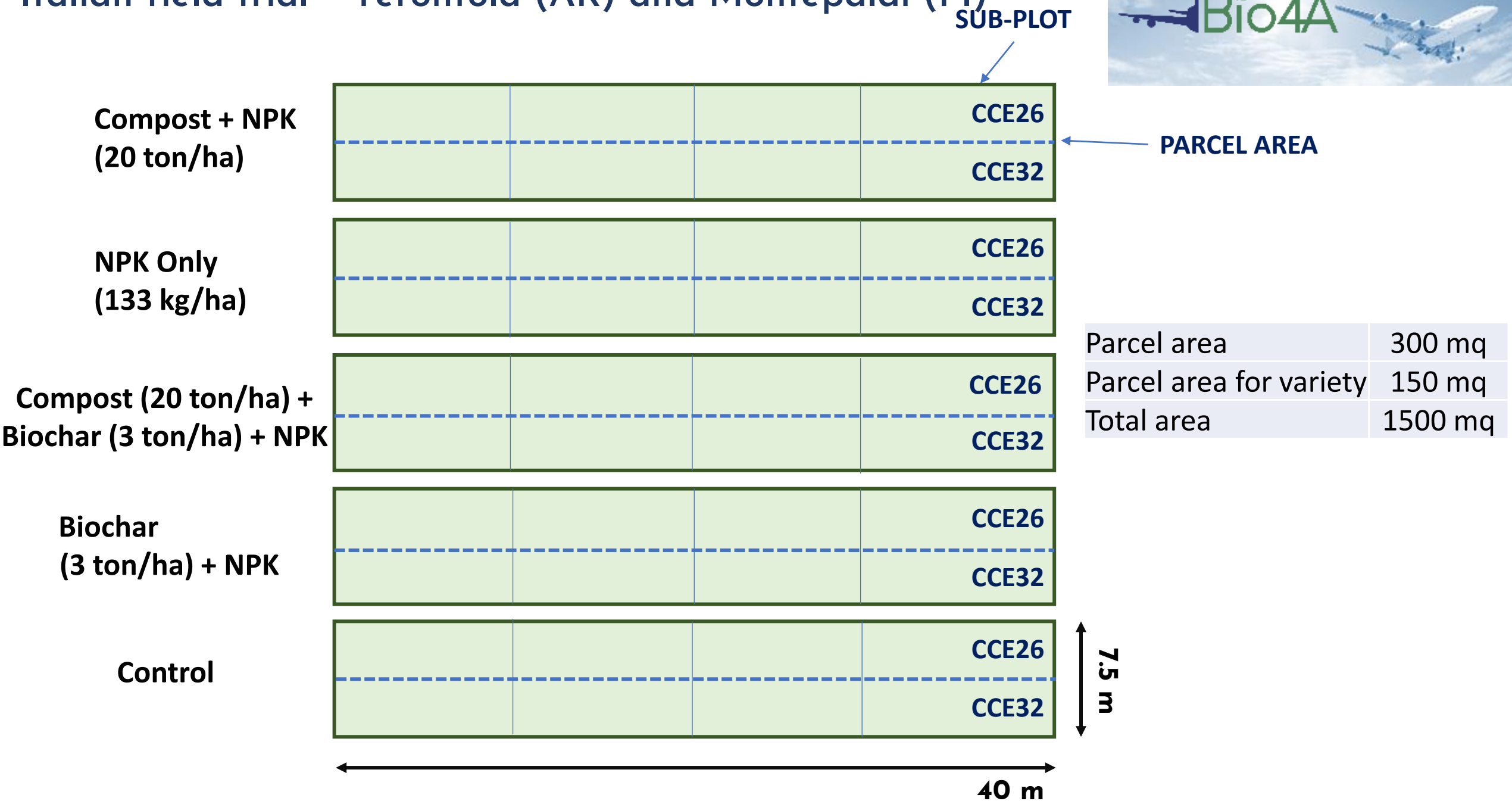
## AGRONOMIC AND ENVIRONMENTAL CONDITIONS

- **Field experiment**
- **2 locations**: **Terontola (Arezzo) and Montepaldi (Florence)**
- 1500 m2 experiment
- **Biochar** from poplar (550°C, slow pirolysis)
- 2 Camelina varieties: short cycle (**CCE26**) and medium cycle (**CCE32**)

## TREATMENTS

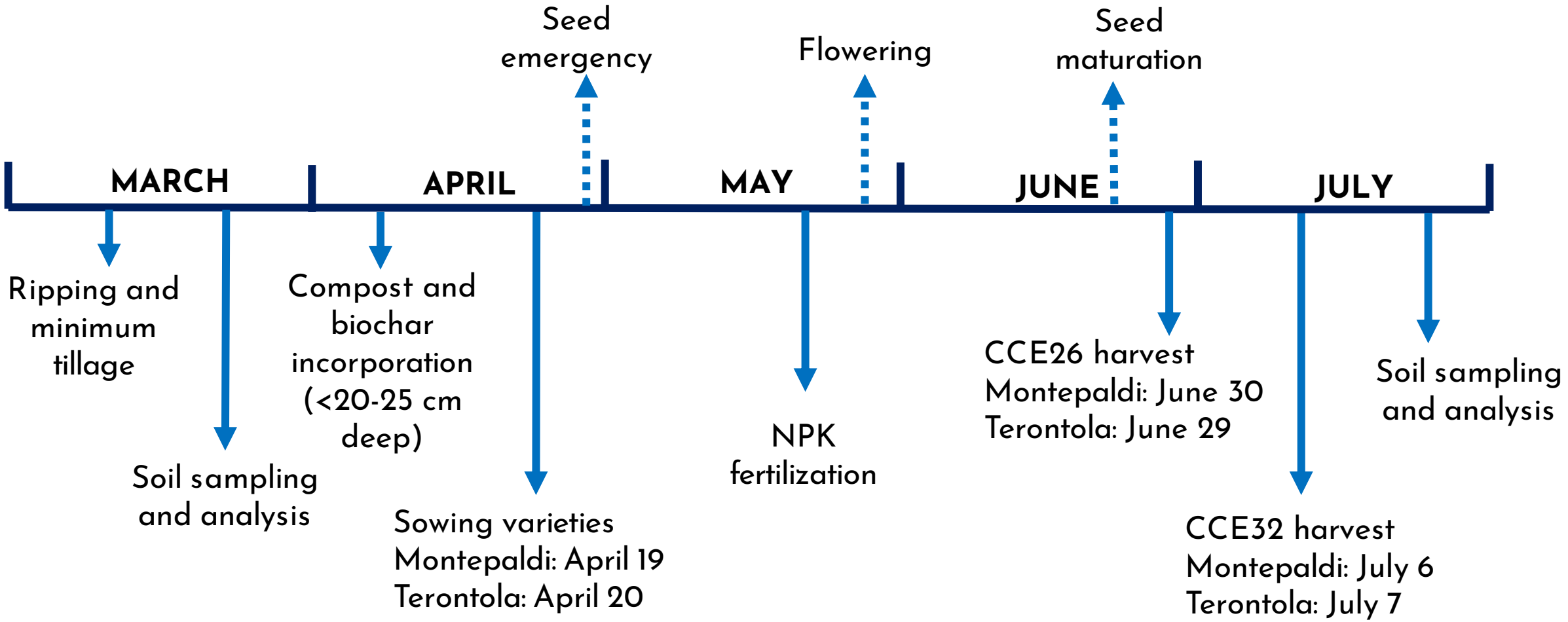
- **CONTROL:** no fertilization or organic amendement
- **NPK FERTILIZATION** (eq. to 133 kg/ha)
- **COMPOST** (eq. to 20 ton/ha) + NPK
- **BIOCHAR** (eq. to 3 ton/ha) + NPK
- **COMPOST** (eq. to 20 ton/ha) + **BIOCHAR** (eq. to 3 ton/ha) + NPK

# Italian field trial - Terontola (AR) and Montepaldi (FI)




| | |
|---|---|
| Parcel area | 300 mq |
| Parcel area for variety | 150 mq |
| Total area | 1500 mq |

# Italian field trial – Agronomic practices and main operations



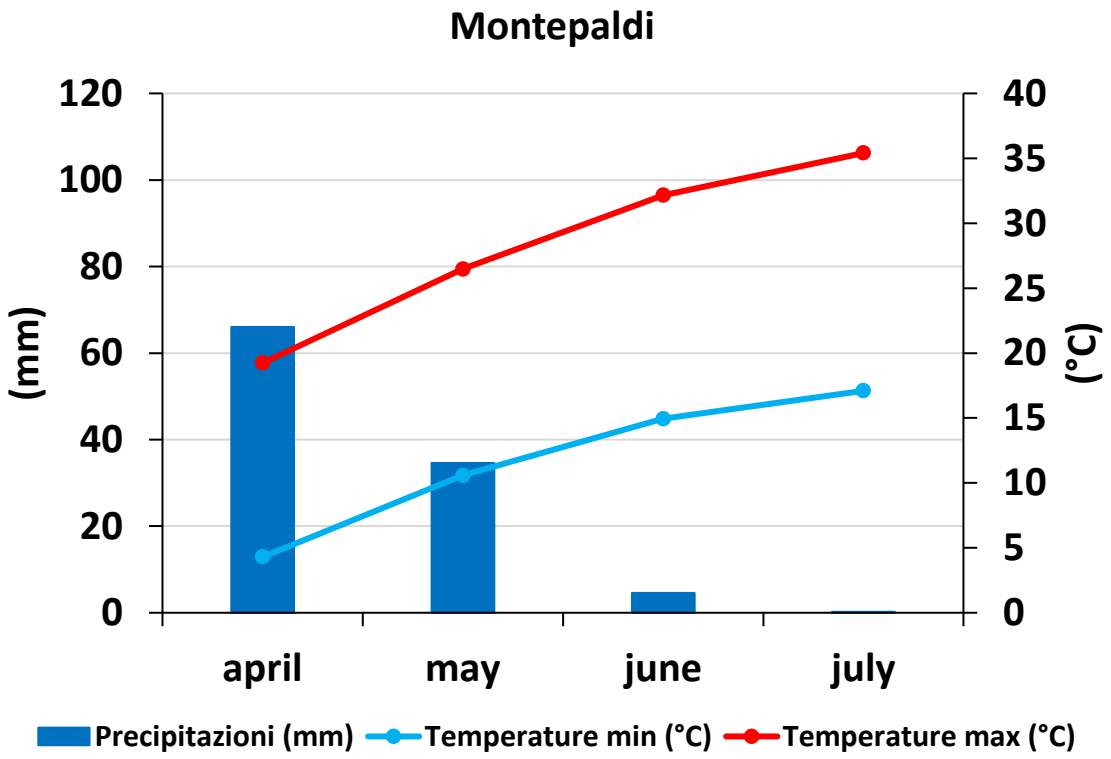
# Italian field trial – Parameters and analysis

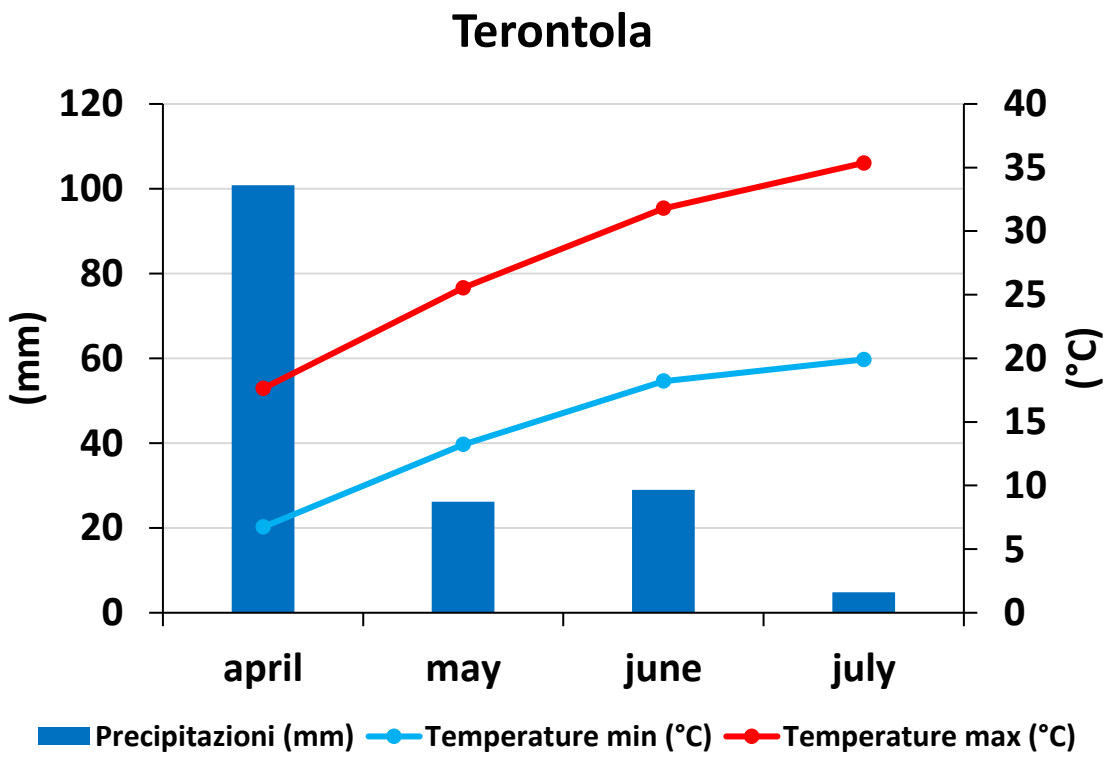
| ANALYSIS | PARAMETERS |
|---|---|
| **Camelina plant** | Biomass |
| | Yield |
| **Camelina oil** | yield + some quality parameters |
| **Biochar** | Full characterization |
| **Compost** | Full characterization |
| **Soil** | Chemical analysis (Before cultivation and at the end of the plant cycle) |
| | pH, EC, CEC |
| | Water holding capacity, bulk density |
| | Total carbon |
| | Organic carbon |
| | P available, P organic, P total |
| | N forms |
| | Macro and micro-nutrient available and total concentration |

# Italian field trial – Terontola

# Italian field trial

# CLIMATIC PARAMETERS from seeding to harvest



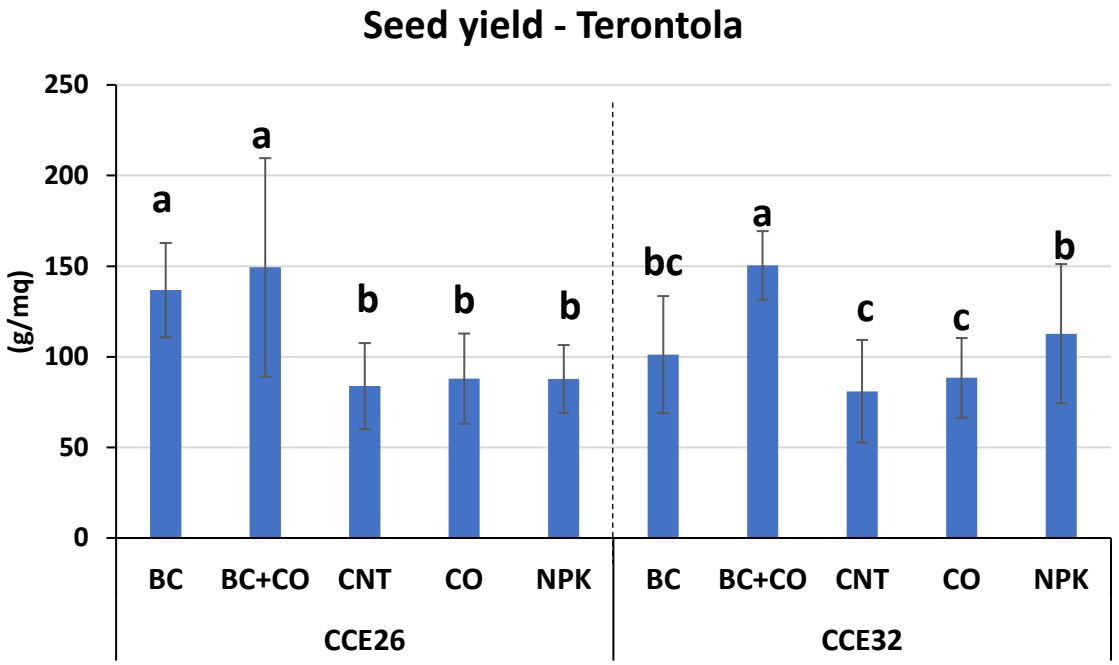



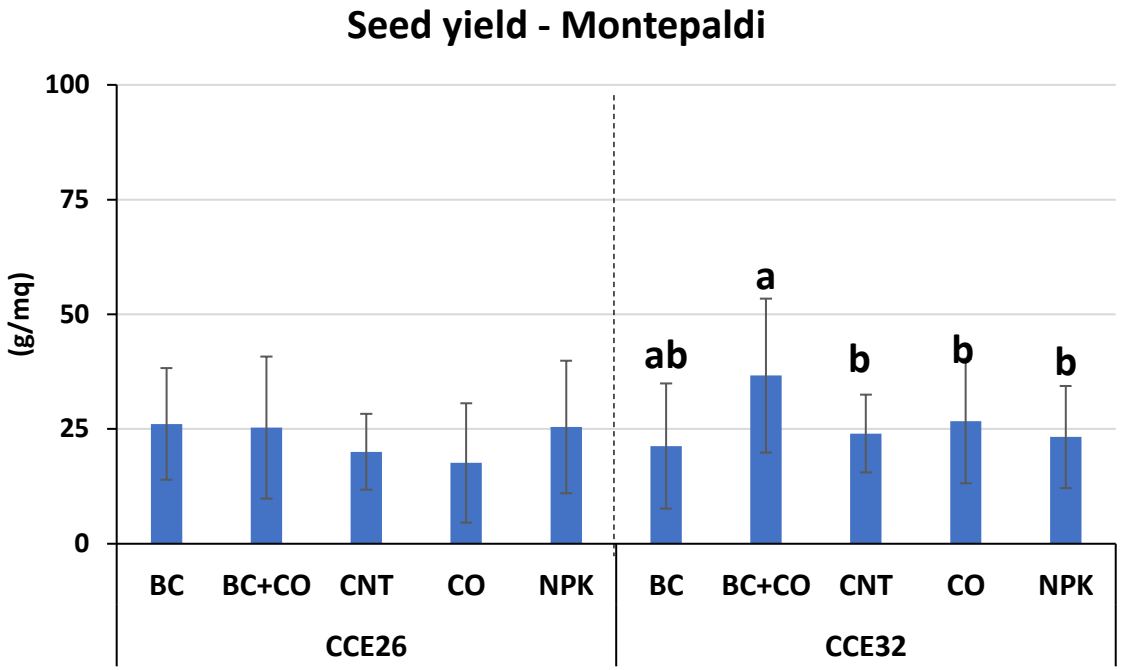

| | Precipitations (mm) | |
|---|---|---|
| | MONTEPALDI | TERONTOLA |
| april | 66.0 | 101 |
| may | 34.6 | 26 |
| june | 4.6 | 29 |
| july | 0.2 | 5 |
| tot | **105.4** | **160.8** |

https://www.sir.toscana.it/consistenza-rete

# Italian field trial – CAMELINA SEED YIELD

Fisher's test p<0.001

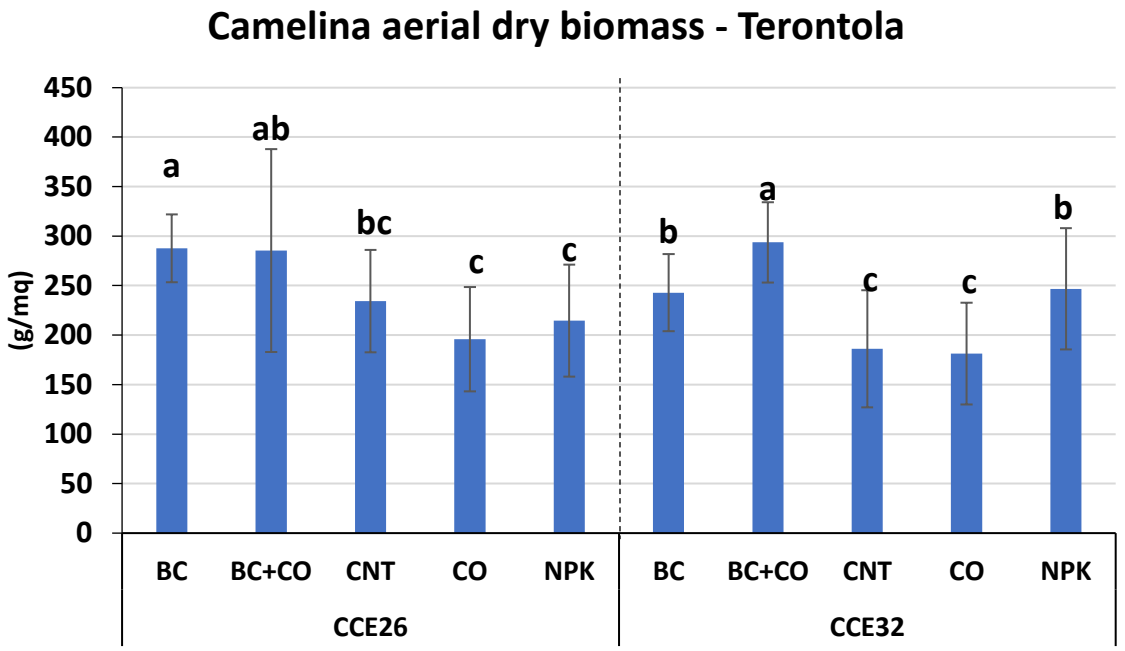


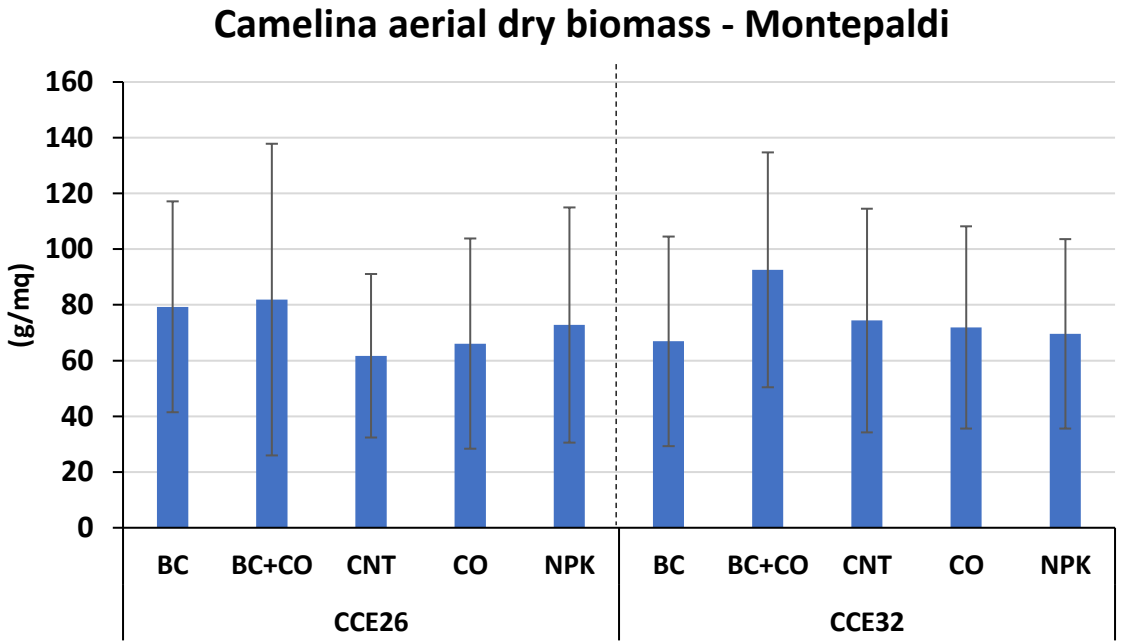




- 12 samples harvested manually for each variety using circular frames
- Camelina plants performed better in Terontola location => probably better agro-environmental conditions
- Statistical differences were detected except for CCE26 in Montepaldi
- The highest yield were collected with biochar + compost

# Italian field trial – CAMELINA DRY BIOMASS AT HARVEST

Fisher's test p<0.001




- Aerial dry biomass includes all plant organs with the exception of seed and root
- Statistical differences were dectected only for Terontola location (high variability in Montepaldi)
- CCE26 highest biomass with biochar; CCE32 highest biomass with biochar + compost