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

RE·CORD

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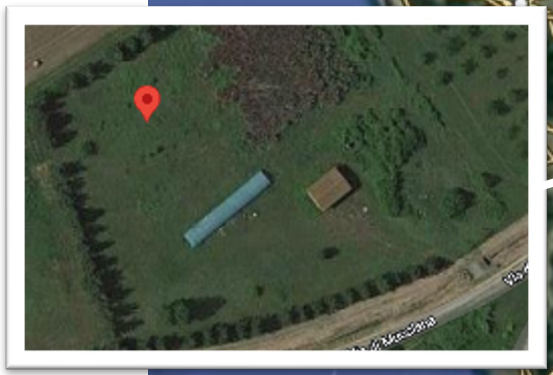
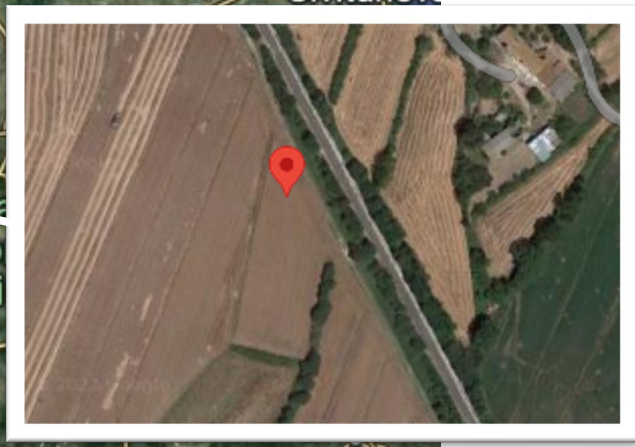
Italian field trials in Montepaldi and Terontola

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

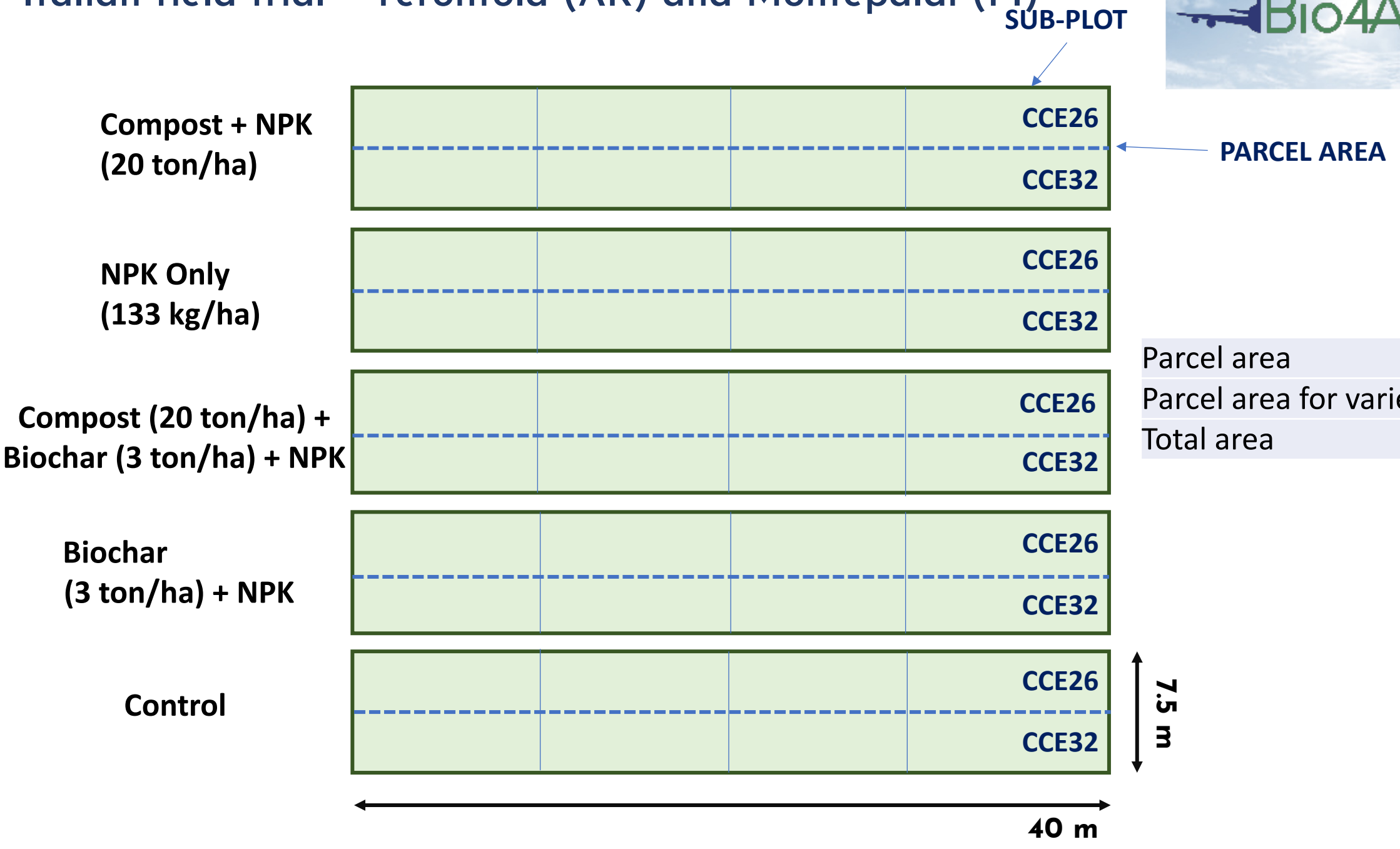
AGRONOMIC AND ENVIRONMENTAL CONDITIONS

- **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

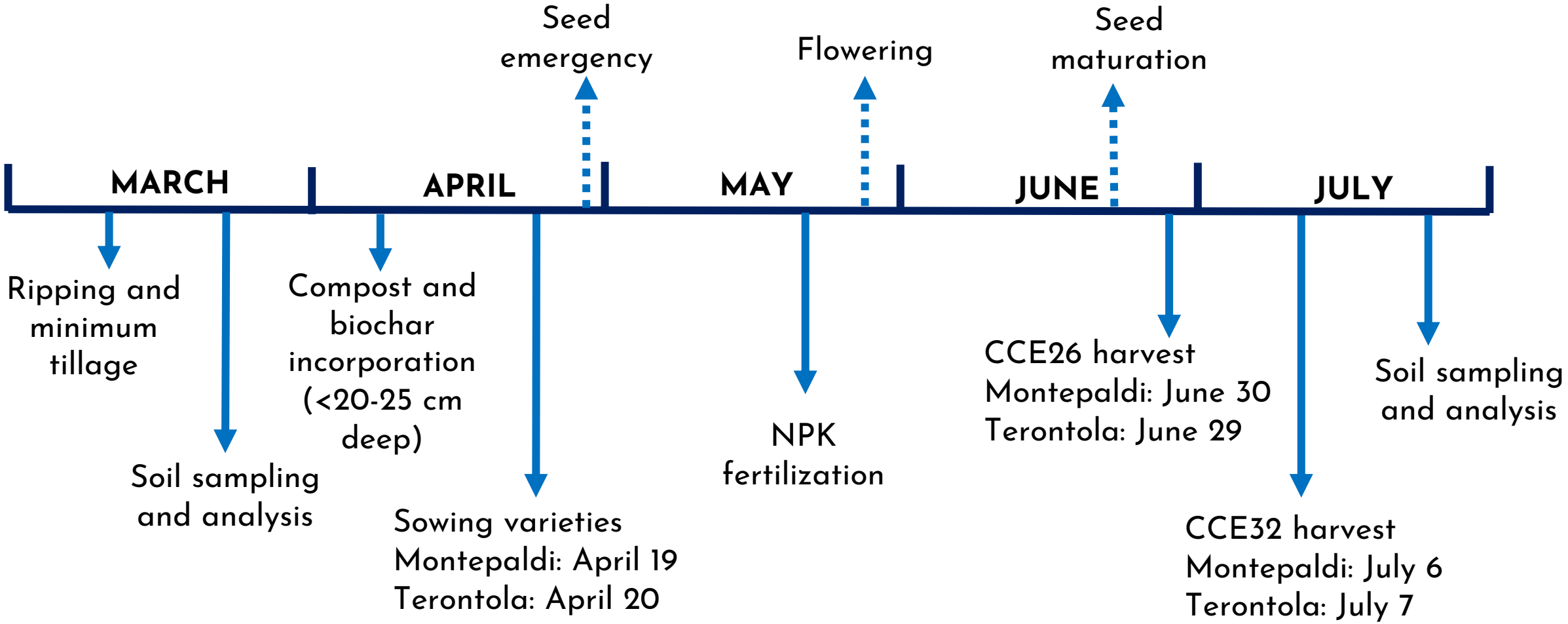
- **CONTROL:** no fertilization or organic amendement
- **NPK FERTILIZATION** (eq. to 133 kg/ha)
- **COMPOST** (eq. to 20 ton/ha) + NPK
- **BIOCHAR** (eq. to 3 ton/ha) + NPK
- **COMPOST** (eq. to 20 ton/ha) + **BIOCHAR** (eq. to 3 ton/ha) + NPK

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



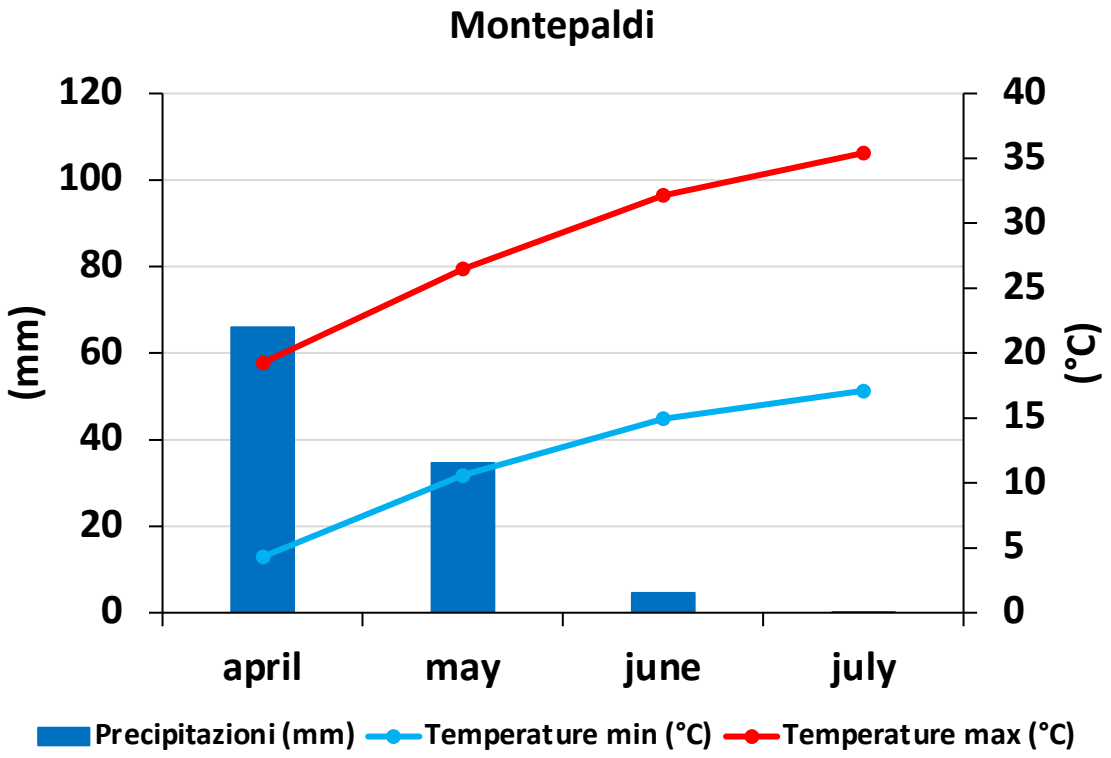
Italian field trial – Parameters and analysis

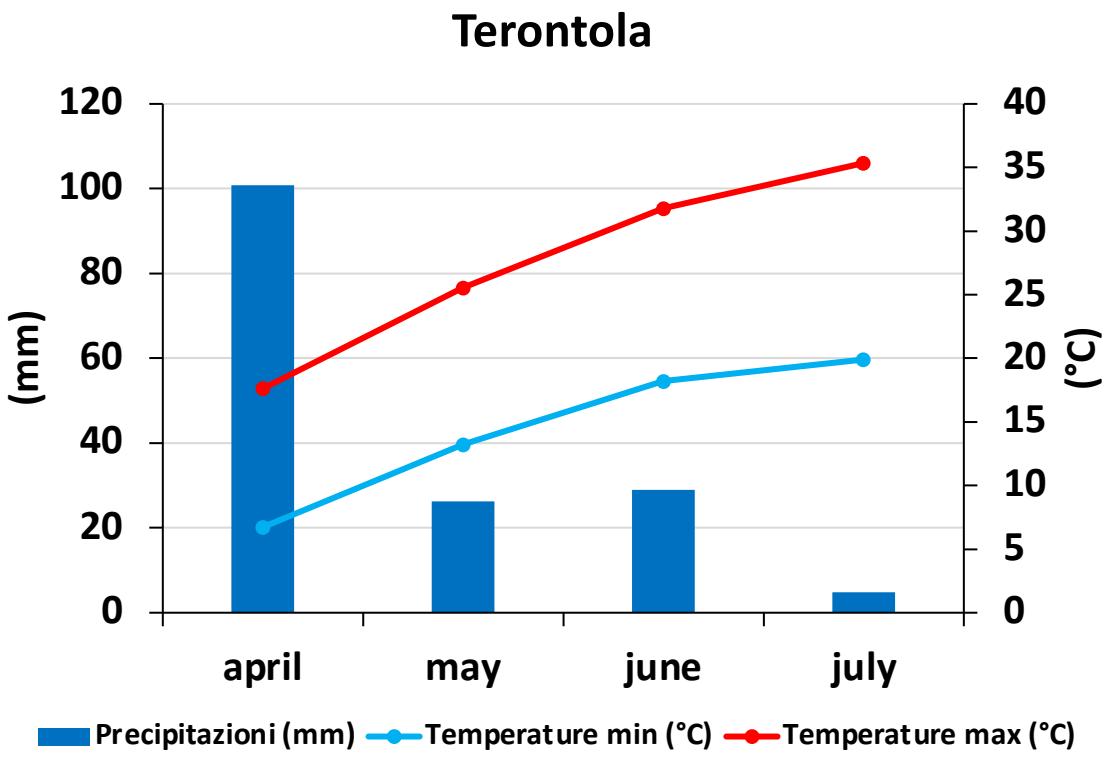
ANALYSIS	PARAMETERS
Camelina plant	Biomass
	Yield
Camelina oil	yield + some quality parameters
Biochar	Full characterization
Compost	Full characterization
Soil	Chemical analysis (Before cultivation and at the end of the plant cycle)
	pH, EC, CEC
	Water holding capacity, bulk density
	Total carbon
	Organic 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



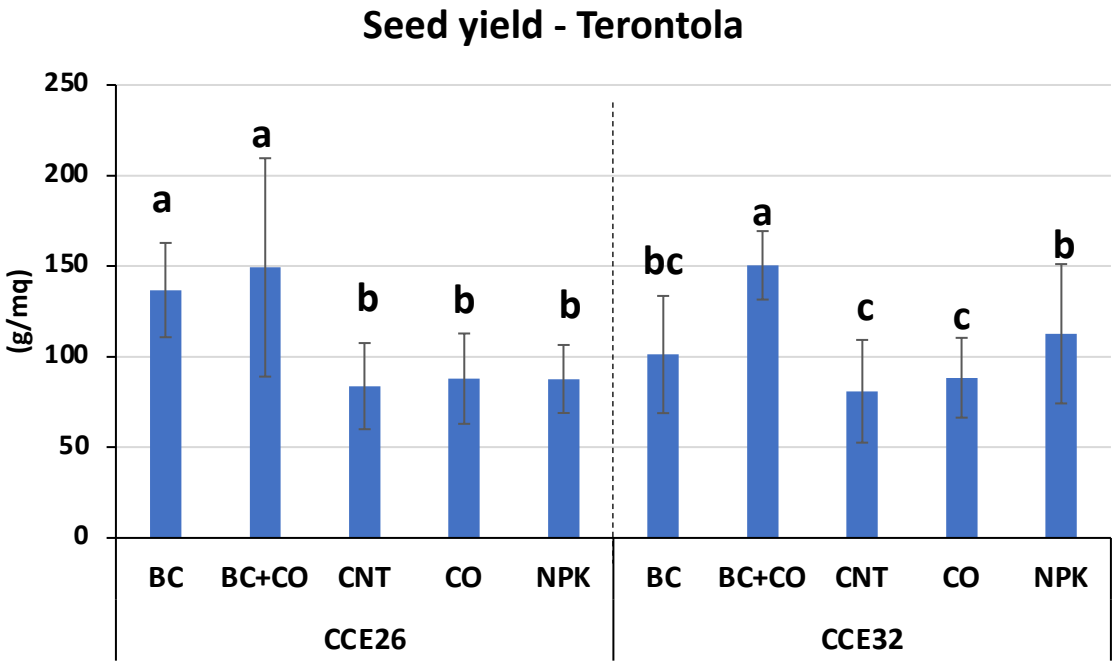


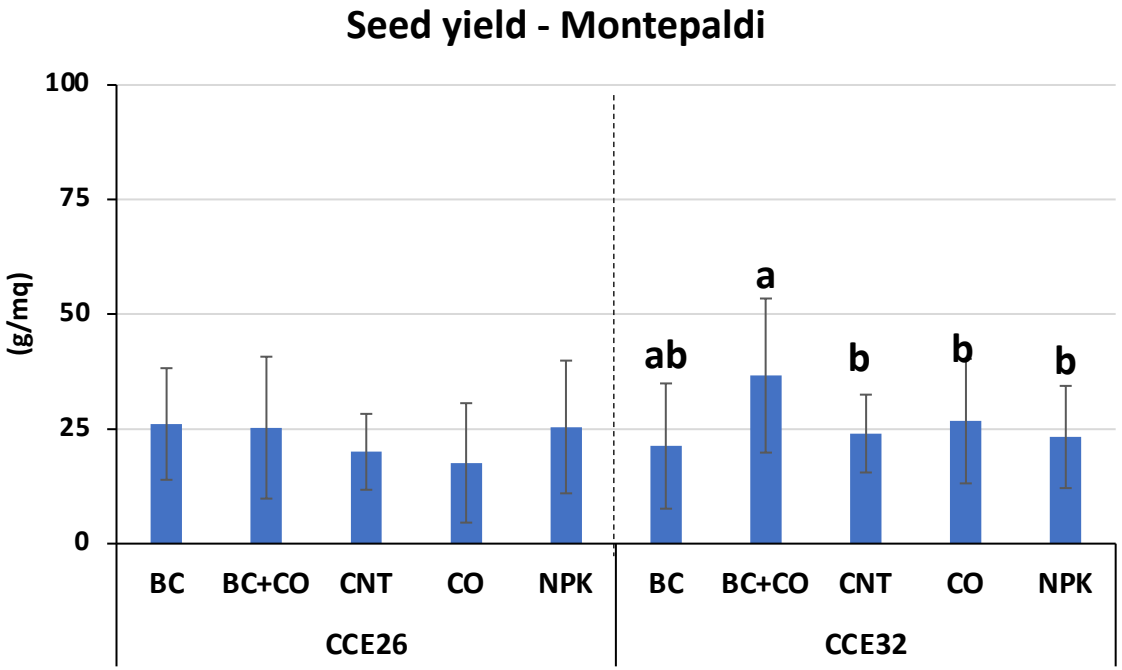
	Precipitations (mm)	
	MONTEPALDI	TERONTOLA
april	66.0	101
may	34.6	26
june	4.6	29
july	0.2	5
tot	**105.4**	**160.8**

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

Italian field trial – CAMELINA SEED YIELD

Fisher's test p<0.001

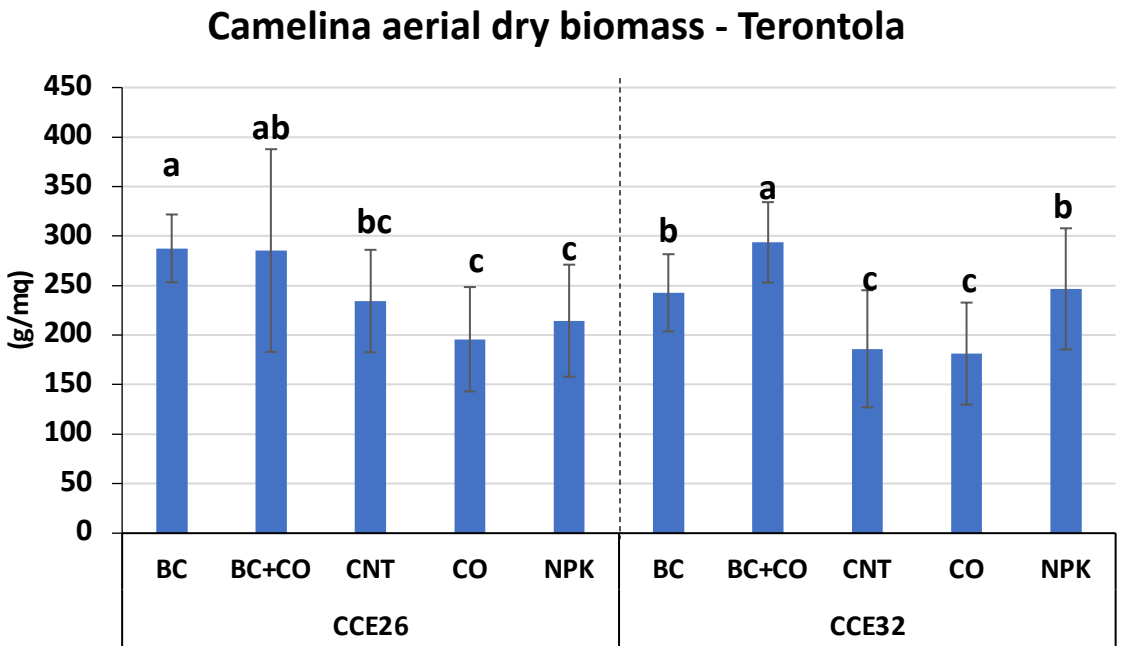


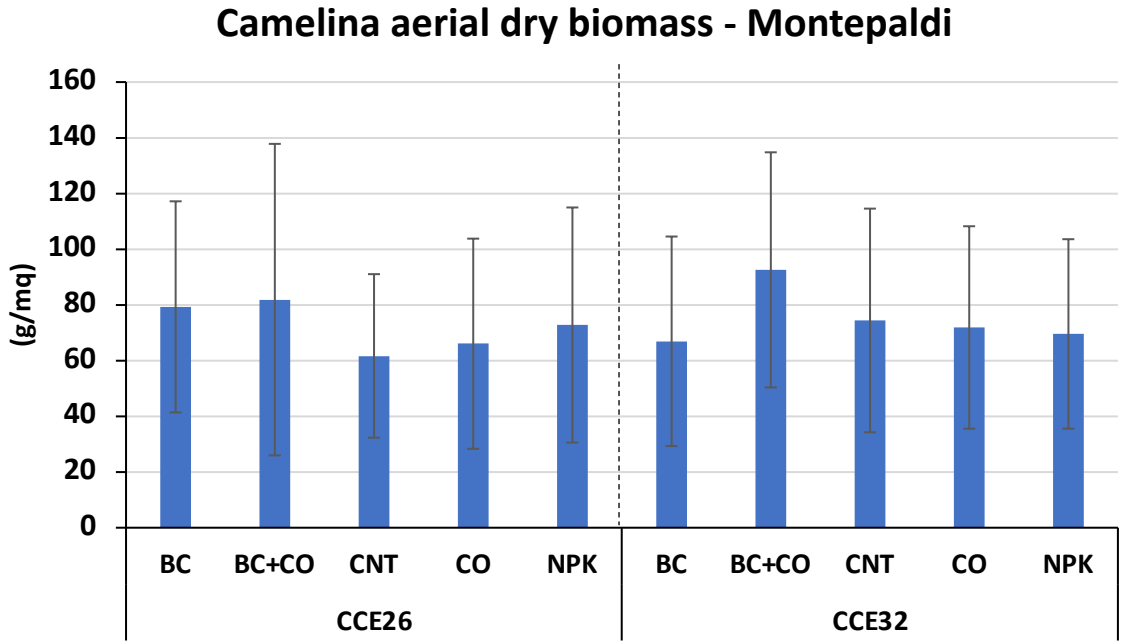


- 12 samples harvested manually for each variety using circular frames
- Camelina plants performed better in Terontola location => probably better agro-environmental conditi
- Statistical differences were detected except for CCE26 in Montepaldi
- The highest yield were collected with biochar + compost

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

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_2eq/MJ should use the following formula to calculate their actual values:

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

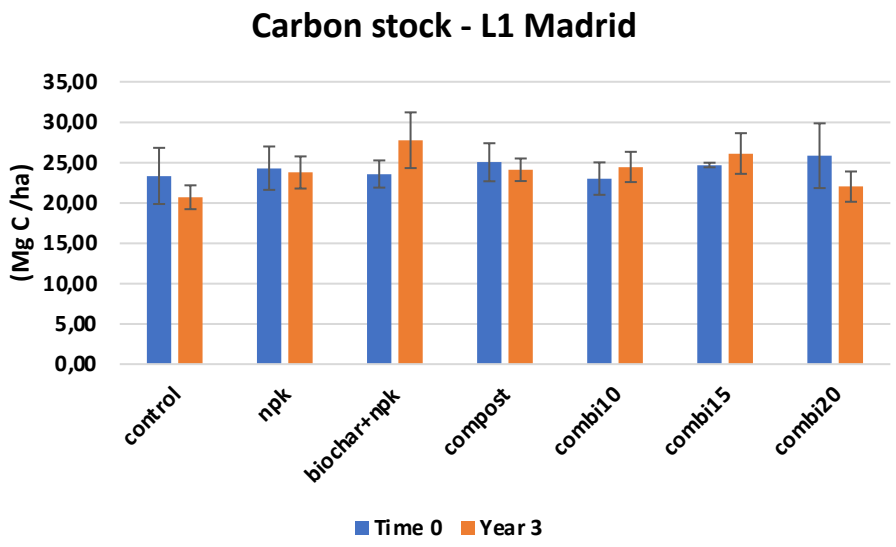
ANNEX V

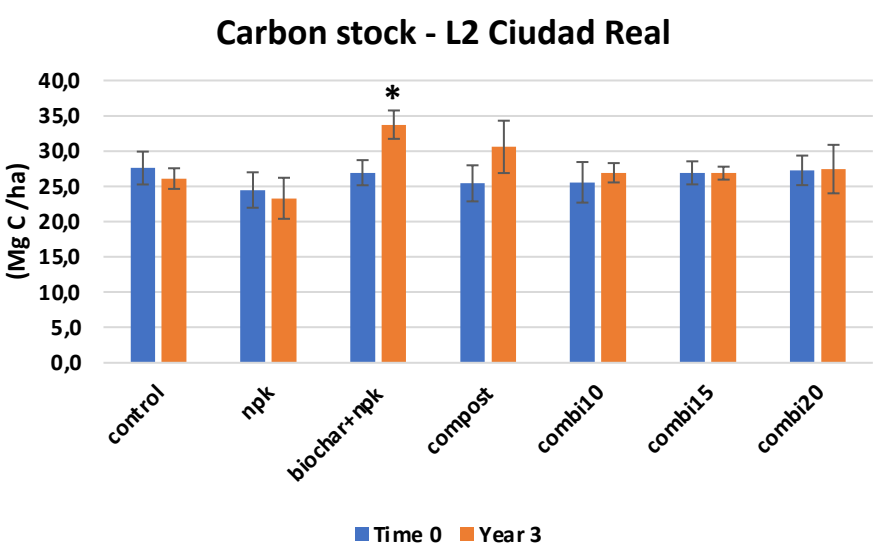
METHODOLOGY FOR DETERMINING THE EMISSION SAVINGS FROM SOIL CARBON ACCUMULATION VIA IMPROVED AGRICULTURAL MANAGEMENT

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