Characterization of technologically produced carbon (CMP) applied in agriculture

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Introduction

The **thermal decomposition of methane** is a process of splitting CH_4 into its components (gaseous hydrogen H_2 and solid carbon C), primarily developed for the **production of hydrogen** (Fig.1).

Triple the amounts of **carbon produced by methane pyrolysis (CMP)** are obtained. This study aims to assess the performance of CMP compared to biochar used in agriculture.

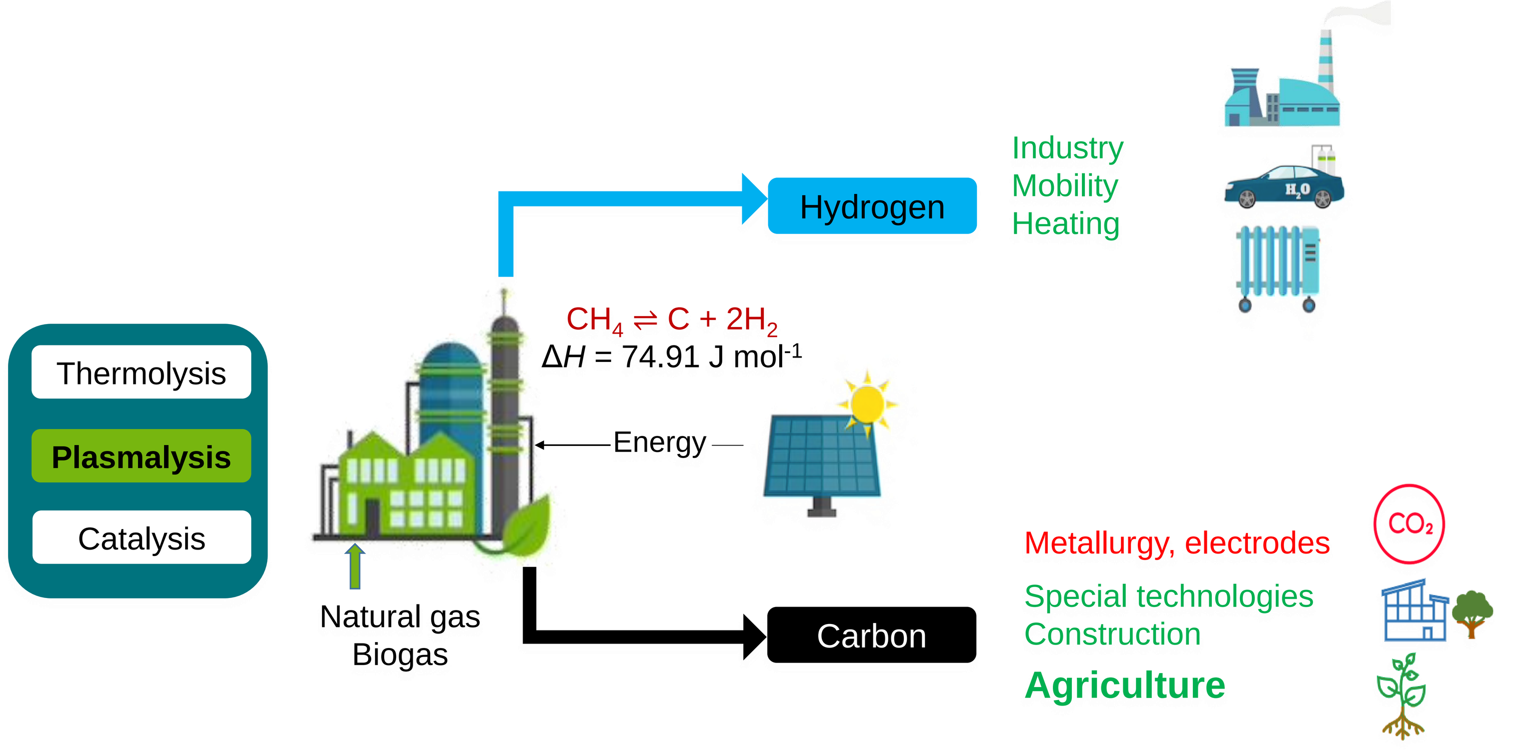


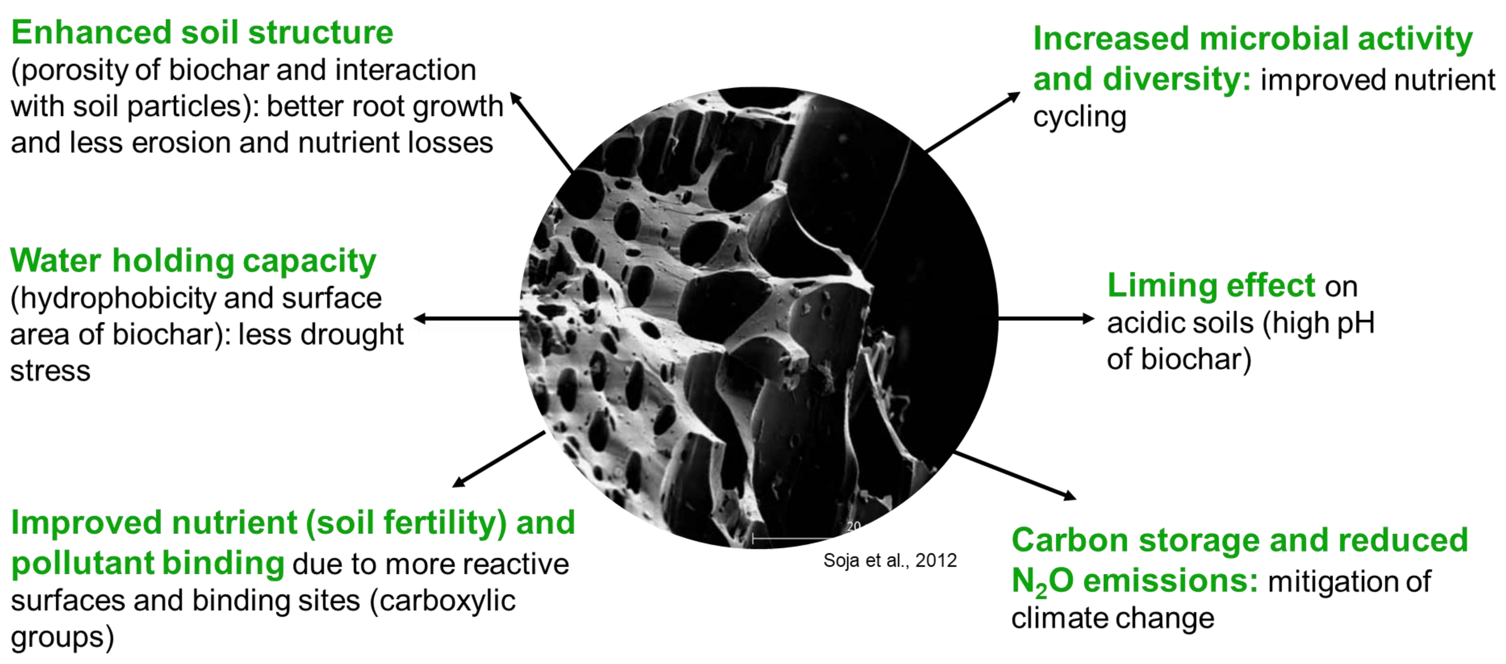
Fig. 1. Pyrolysis of methane and potential application areas of hydrogen and carbon produced by methane pyrolysis (based on flaticon.com)

Aim of study

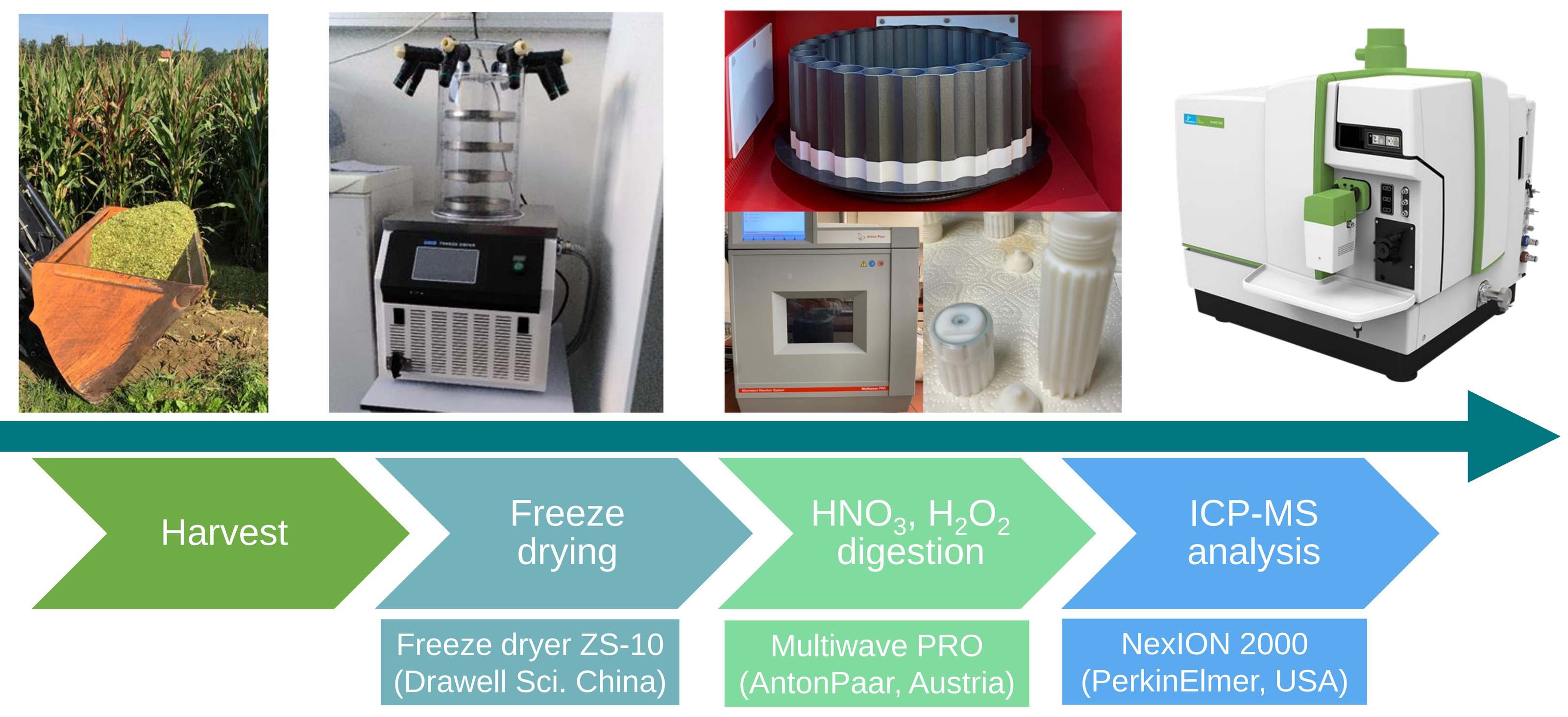
I. **Analysis** of the chemical and physical properties of carbon produced by methane pyrolysis in comparison to biochar
II. **Investigation** of the potential of CMP for **agricultural application**
III. **Evaluation** of soil improvement, plant growth characteristics, and nutrient uptake of maize plants as a result of the use of CMP

Carbon in agriculture

Benefits of applying carbon to the soil



Methodology



Part I: CMP characterisation

Chemical data relative to European Biochar Certificate (EBC)

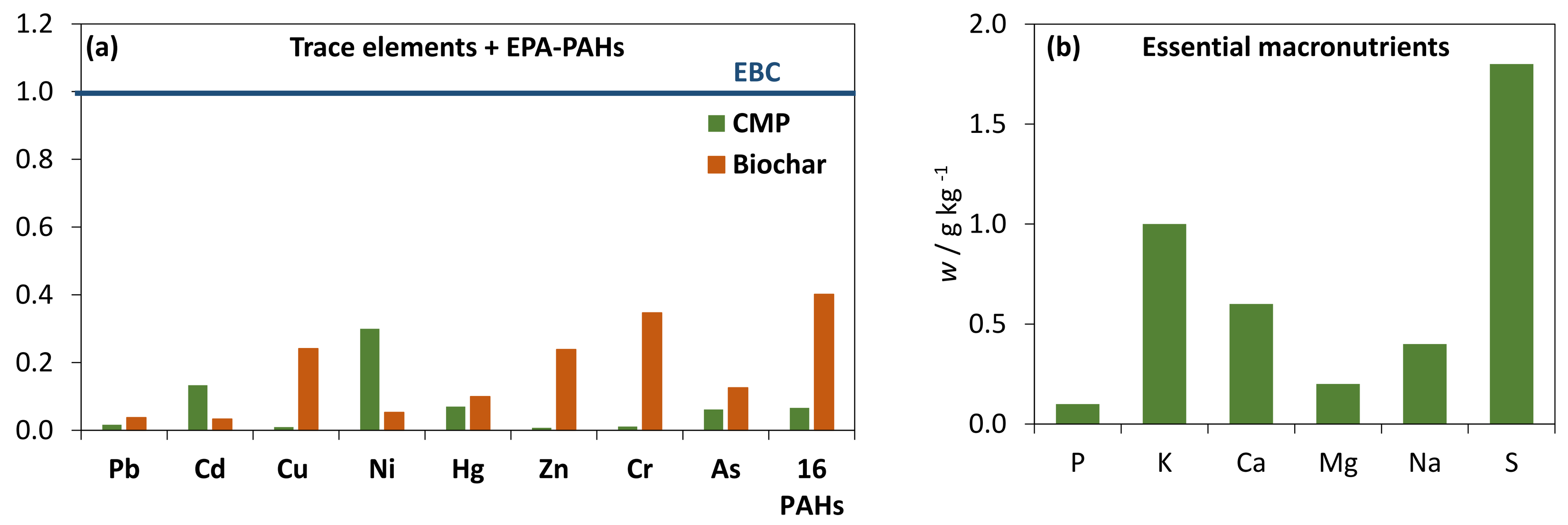


Fig. 2. (a) Trace element and polycyclic aromatic hydrocarbon (PAHs) levels in CMP and biochar relative to EBC. (b) Total mass fractions of essential macronutrients in CMP.

Observation: parameters are significantly below EBC thresholds (Fig. 2)

Part II: Greenhouse experiment

Set up (Fig. 3)

I. Maize (*Zea mays*)
II. Control, 10 g kg^{-1} biochar,
III. 1, 5, 10 and 25 g kg^{-1} added CMP
IV. Six weeks
V. 22/18°C day/night

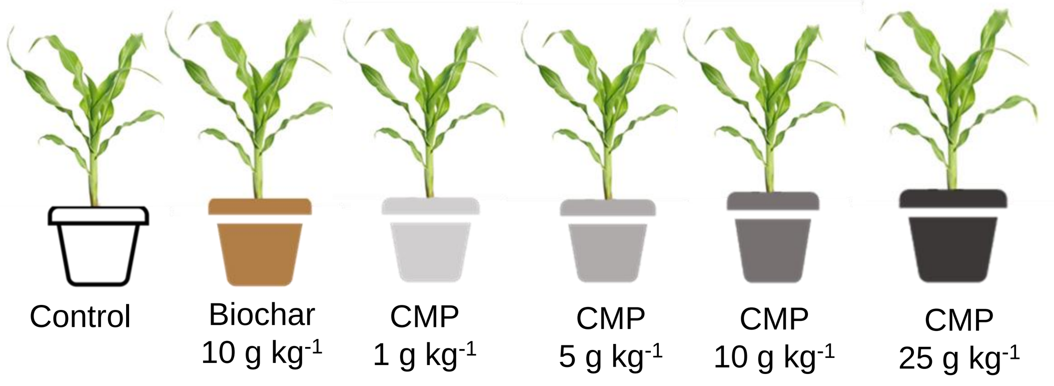


Fig. 3. Illustration of the added quantities of biochar and CMP

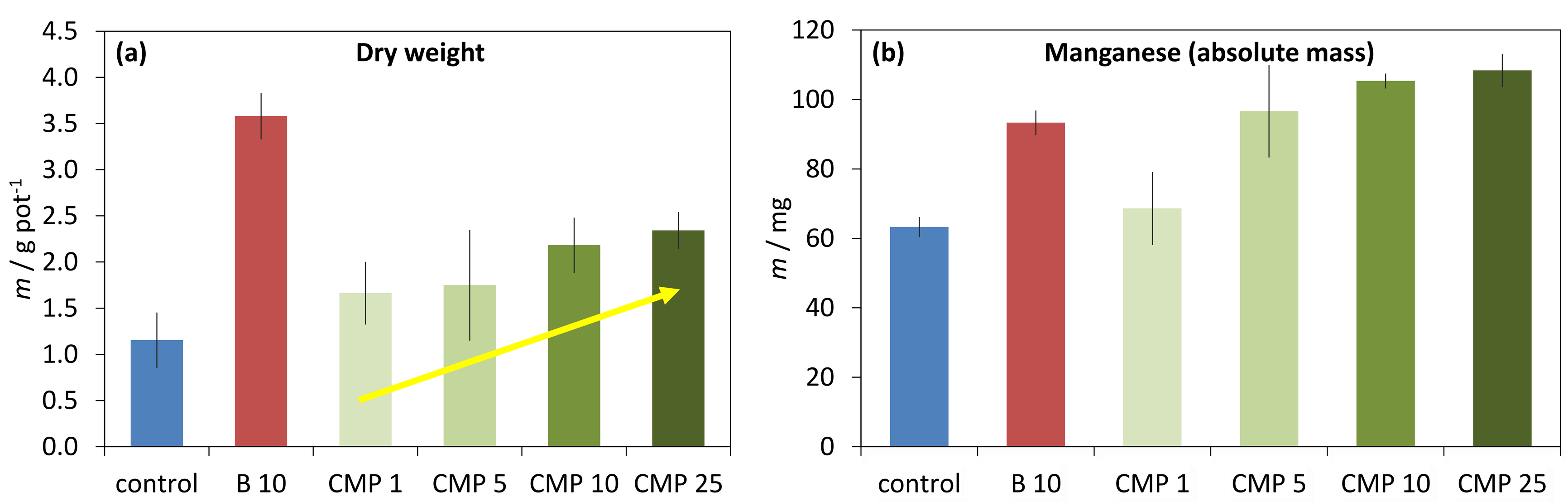


Fig. 4. Dry weight (a) and total mass of manganese (b) in aboveground maize tissues. Error bars: SD (n=3).

Observation

- Biomass tends to increase with higher CMP supply (Fig. 4)
- Total mass fraction of selected nutrients in aboveground maize tissues treated with CMP is higher than the control and comparable to biochar treated maize tissues (Fig. 4)

Reference: Soja, Gerhard & Zechmeister-Boltenstern, Sophie & Kitzler, Barbara & Lauer, Max & Liedtke, Volker & Watzinger, Andrea & Wimmer, Bernhard & Zehetner, Franz. (2012). Biochar for Agricultural Soils. GAIA. 21. 236-238.

Part III: Field experiment

Set up (Fig. 5)

I. Maize (*Zea mays*)
II. Plot size: 40m^2
III. Added CMP: 1% CMP 112 kg per plot, 2.8 kg / m^2

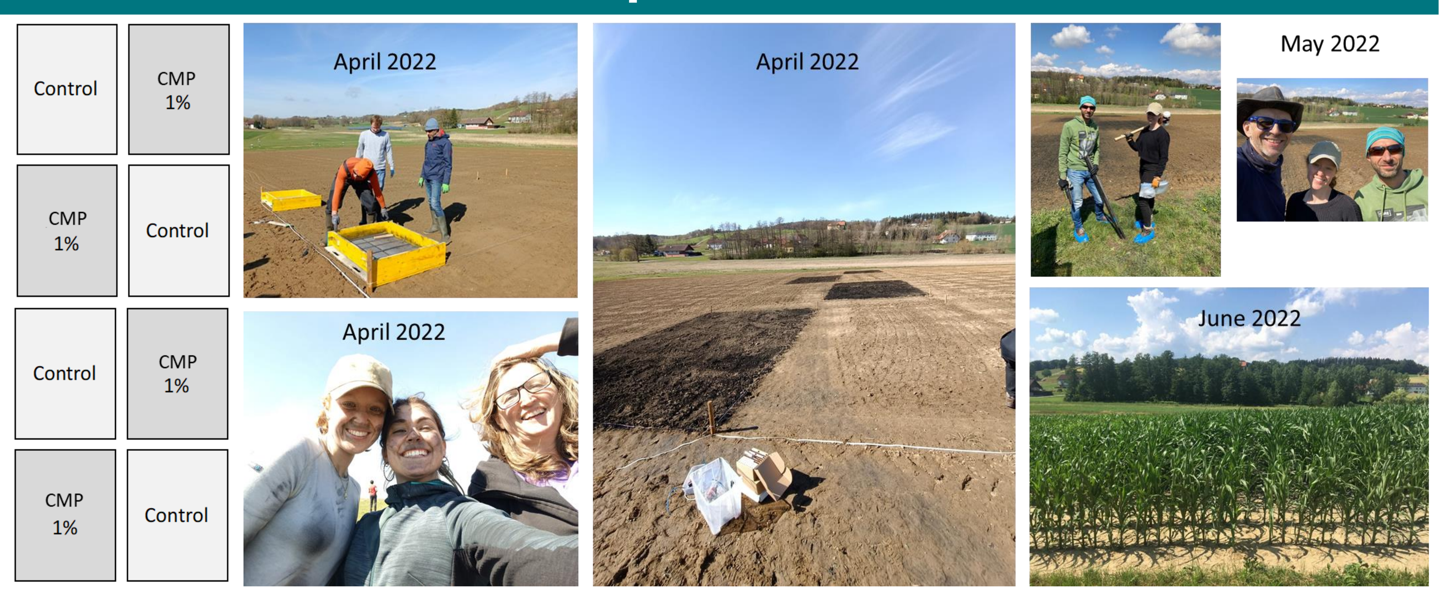


Fig. 5. Experimental plan and set up of the field experiment

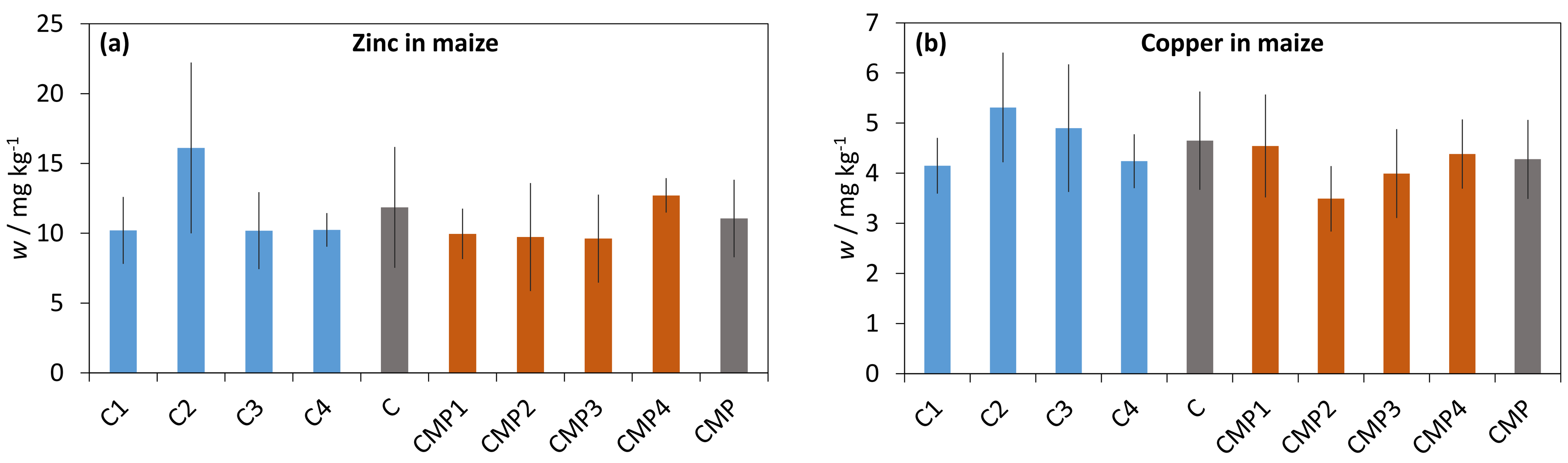


Fig. 6. Mass fraction of zinc (a) and copper (b) in aboveground maize tissues. Error bars: SD (n=5)

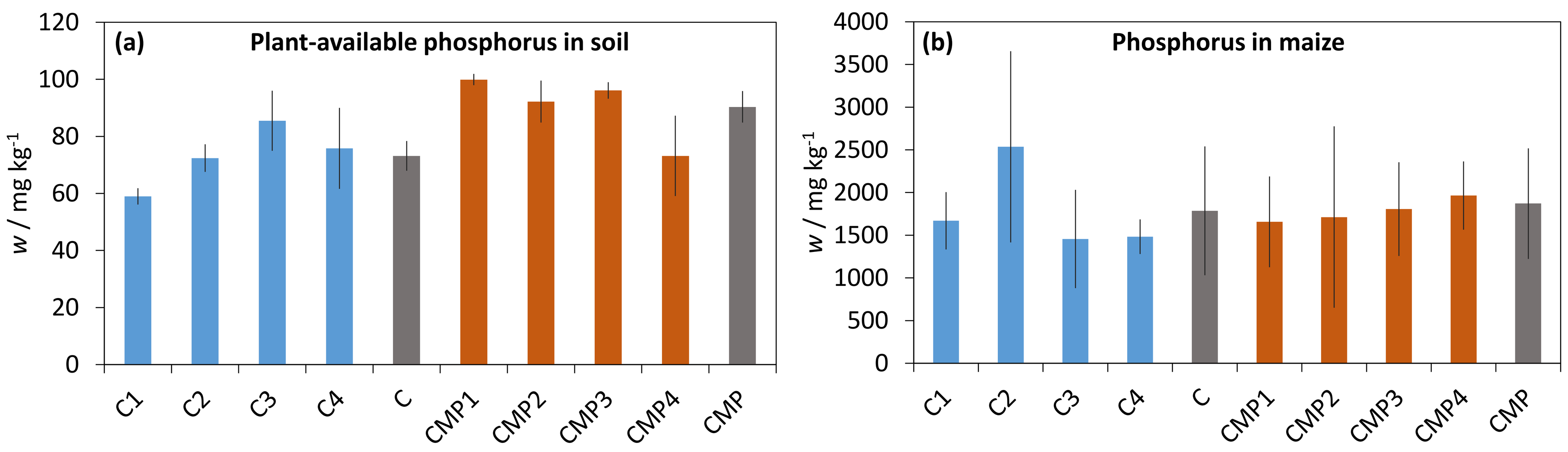


Fig. 7. Comparison of plant-available phosphorus in soil (a) and mass fraction of phosphorus in aboveground maize tissues (b). Error bars: (a) SD (n=3) (b) SD (n=5)

Observation

CMP has no negative effect on the nutrient concentration in maize (Fig. 6)

Plant available P in the soil tends to be higher in CMP treated soils (Fig. 7)

Results & Conclusions

- Carbon produced by methane pyrolysis (CMP) has potential for use in agriculture
- Depending on the soil, CMP is able to increase biomass
- CMP could be applied on soil in combination with soil additives, manure or compost

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