Landwirtschaftliche Anwendung von Kohlenstoff aus der Methan-Pyrolyse

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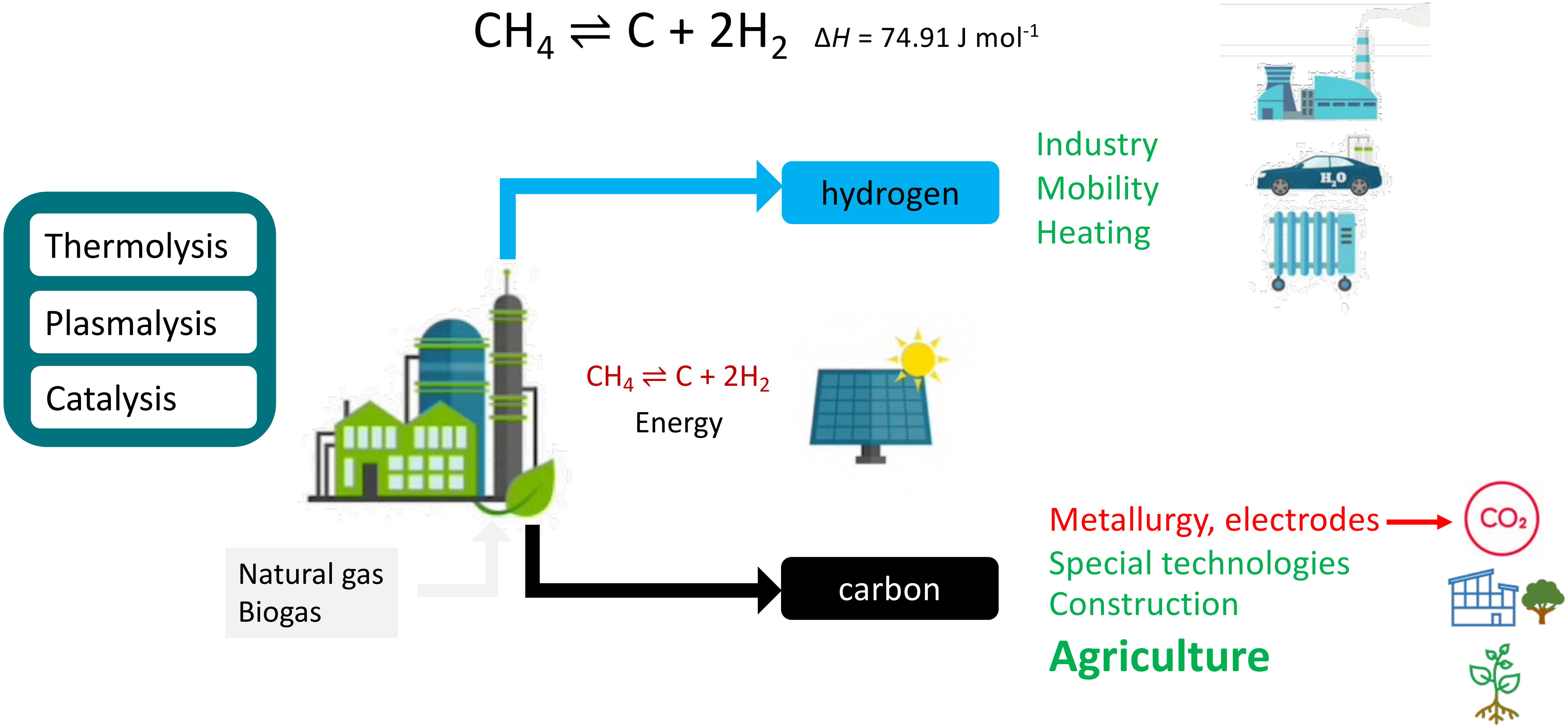
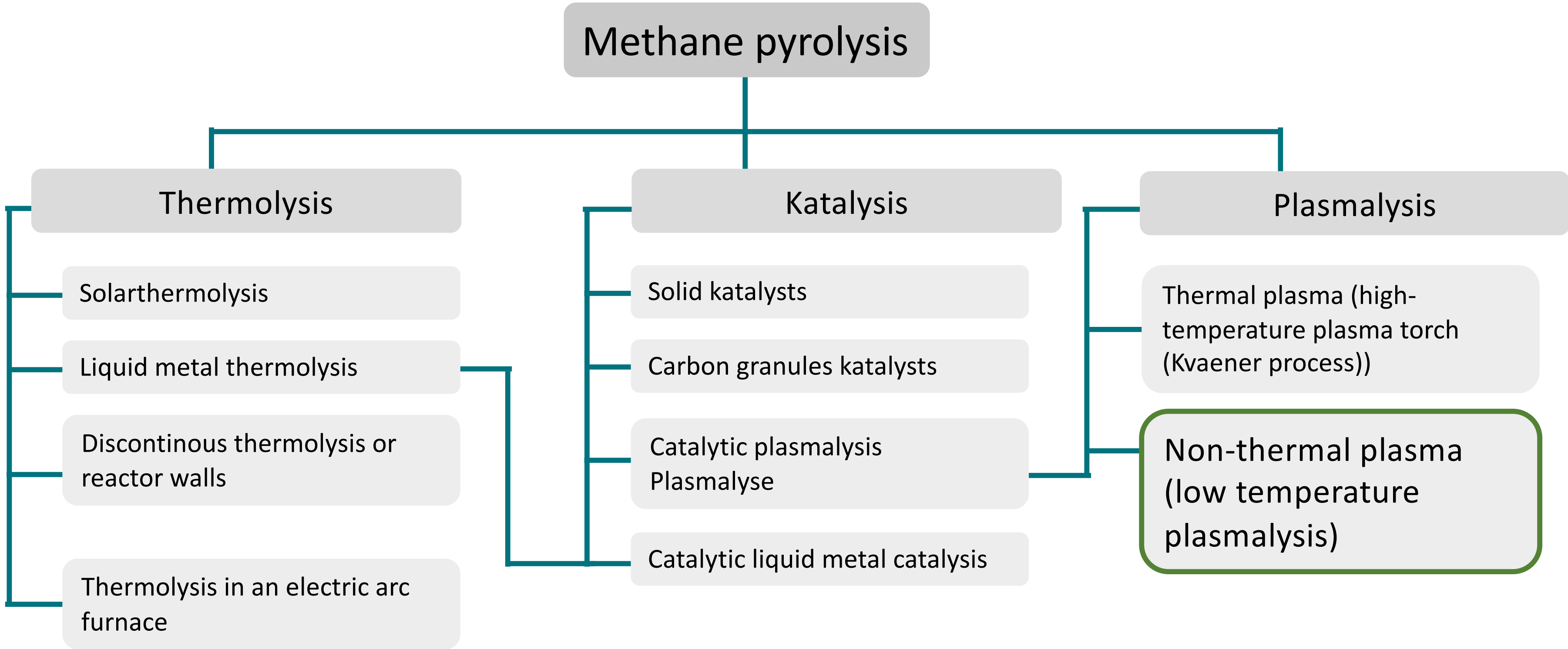
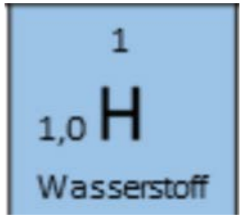
Source of the carbon: pyrolysis of methane

$CH_4 \rightleftharpoons C + 2H_2$ ΔH = 74.91 J mol^{-1}



Source of the carbon: pyrolysis of methane





Hydrogen production by non-thermal plasmalysis

- A **non-thermal plasma** is used to convert methane into hydrogen and solid carbon (carbon black).
- The non-thermal plasma is **generated by a high-frequency electric field**, which leads to the ionization of the methane.
- The **electrons** inside **reach energies of temperatures of 10 000 to 100 000 K** (at energies of 1-10 eV) leading to decomposition of methane.
- The **gas temperature remains at room temperature**.

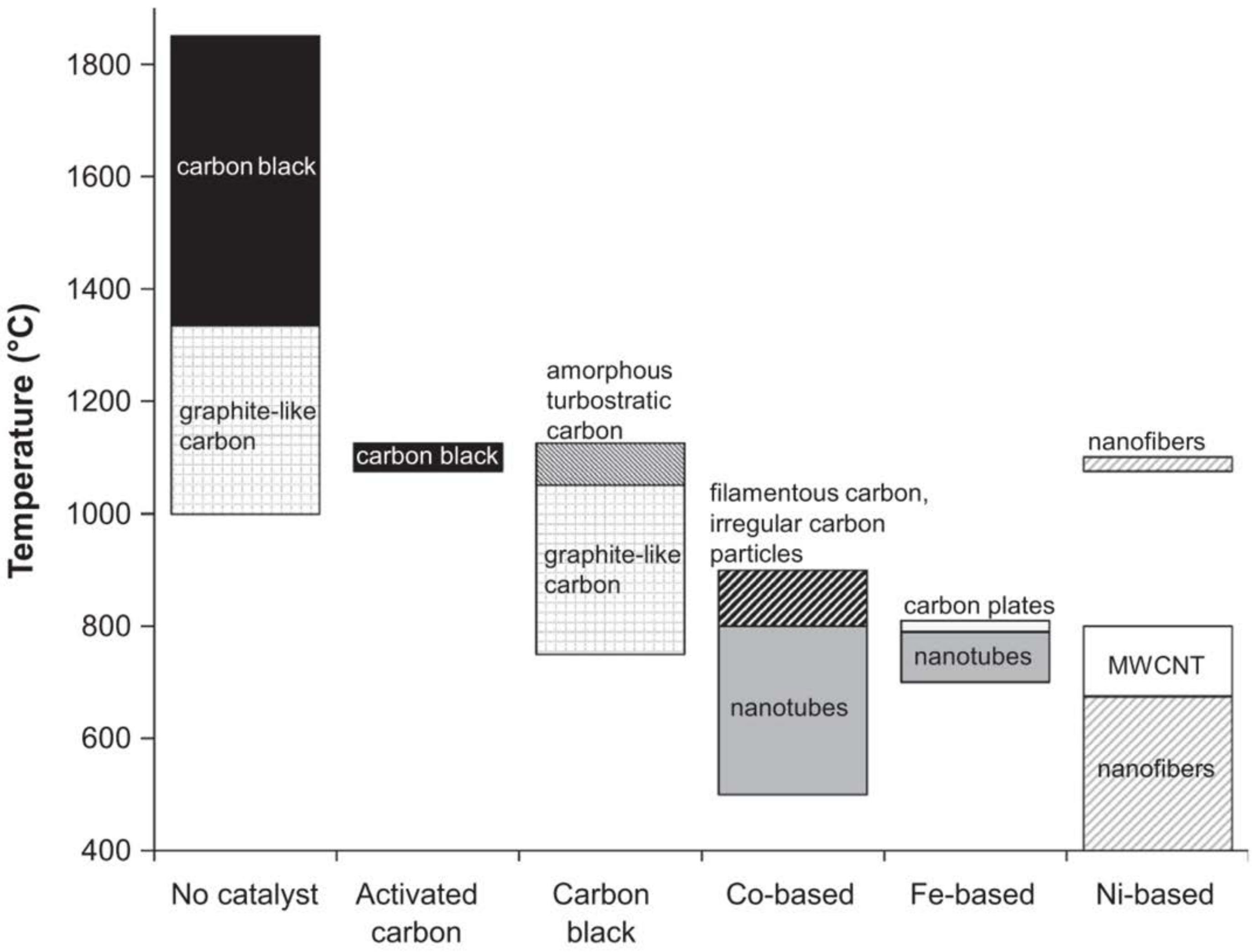


Fig. 2. Main carbon products obtained as a function of temperature and catalyst employed in the TDM reaction.

Thermo-catalytic decomposition of methane (TCD) yields a range of carbon products depending on reaction parameters

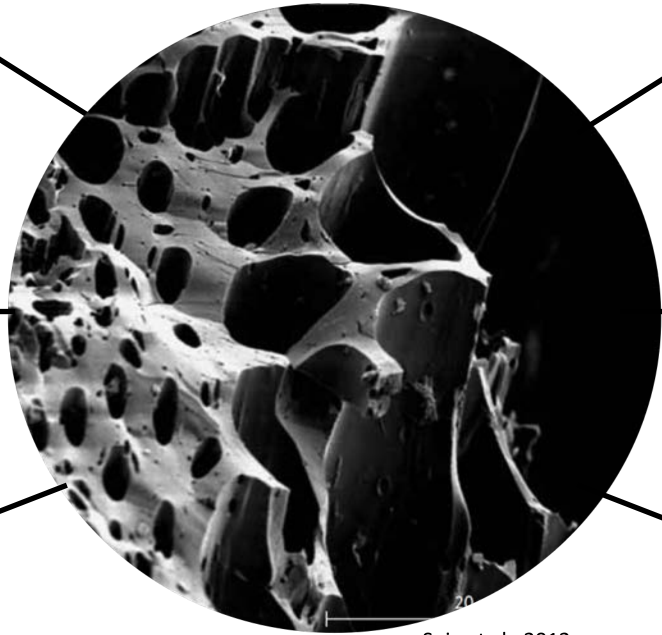
Keipi et al., 2016

Effects of biochar on soil characteristics and functions

Enhanced soil structure (porosity of biochar and interaction with soil particles): better root growth and less erosion and nutrient losses

Increased microbial activity and diversity: improved nutrient cycling

Water holding capacity (hydrophobicity and surface area of biochar): less drought stress



Soja et al., 2012

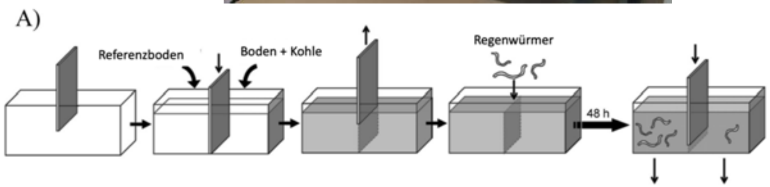
Liming effect on acidic soils (high pH of biochar)

Improved nutrient (soil fertility) and pollutant binding due to more reactive surfaces and binding sites (carboxylic groups)

Carbon storage and reduced N_2O emissions: mitigation of climate change

Does carbon from plasmalysis comparable effects in soils as biochar?

1. **Chemical characterisation of the carbon according to EBC**



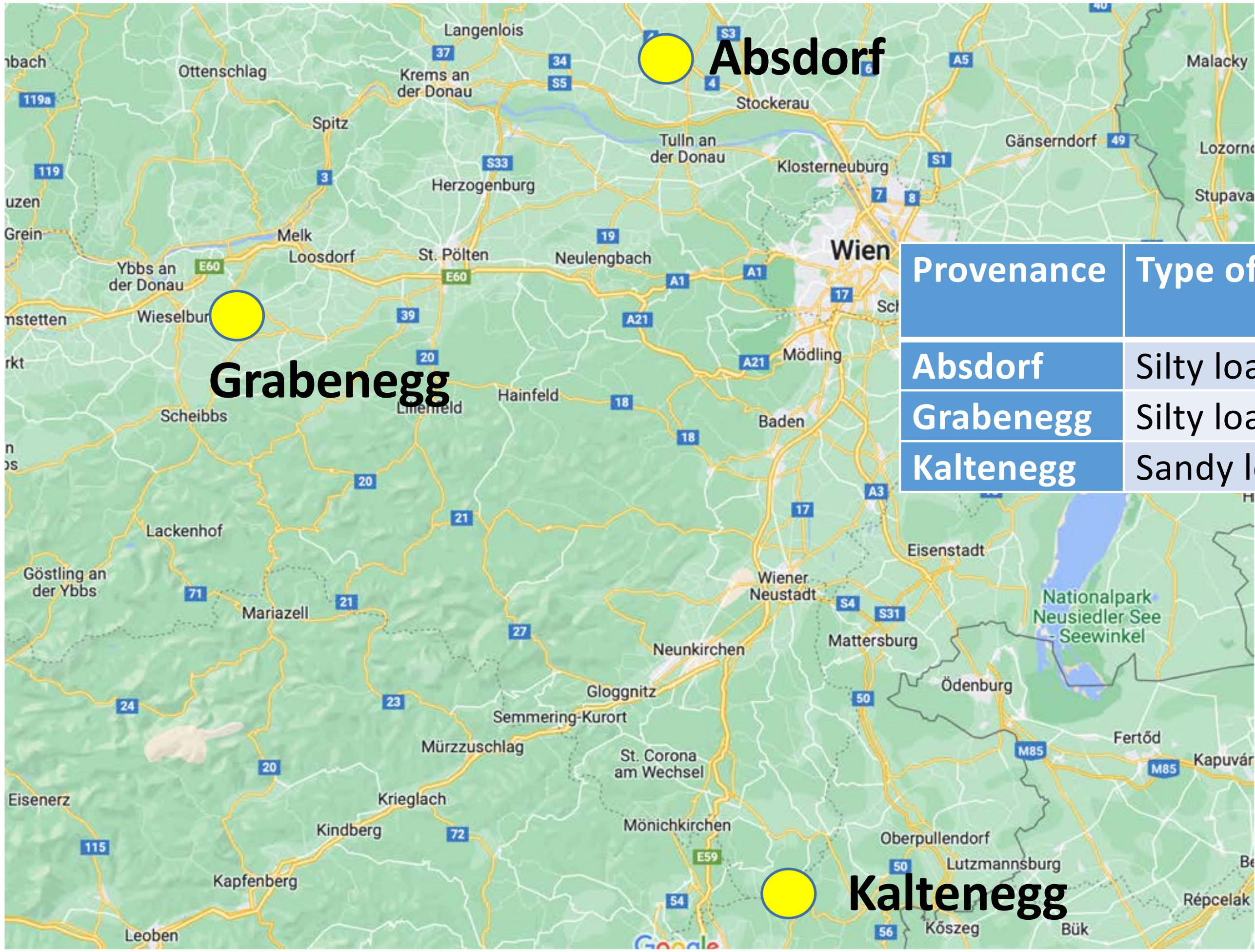
2. **Batch experiment –** testing different amendment rates in the laboratory
3. **Earthworm avoidance test**

4. **Pot experiments** in the greenhouse
5. **Field experiments**

Chemical characterisation of plasmalysis-derived carbon

- pH value
- Soluble and polycyclic aromatic hydrocarbons (PAH)
- Element (Heavy metal) content
- Extractable and purgable organohalogens (EOX, POX)

Soil types used in the first experiments



Provenance	Type of soil	pH	Humus (%)	Lime content (%)
Absdorf	Silty loam	7,6	3,7	22,8
Grabenegg	Silty loam	5,4	1,7	0
Kaltenegg	Sandy loam	4,6	5,1	0

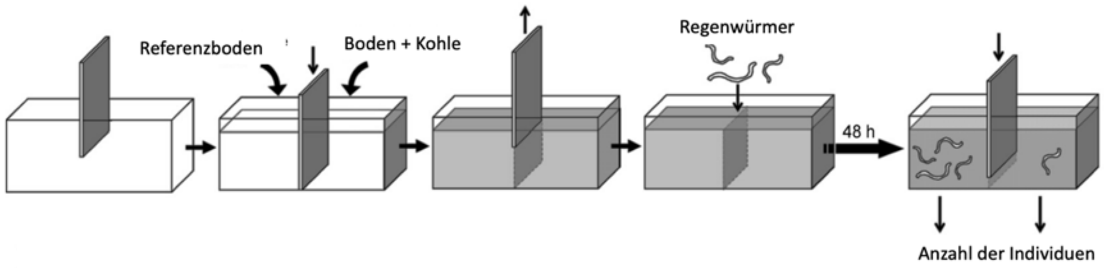
Greenhouse experiment

Code	Treatments:
C	Soil (no amendments)
P0.1	Soil + 0.1 % **carbon** (m/m)
P0.5	Soil + 0.5 % **carbon** (m/m)
P1	Soil + 1 % **carbon** (m/m)
P2.5	Soil + 2.5 % **carbon** (m/m)
B1	Soil + 1 % **biochar** (m/m)
G1	Soil + 1 % **graphite** (m/m)
PV0.1	Soil + 0.1 % **carbon**+0.1% **vermicompost** (m/m)
PV0.5	Soil + 0.5 % **carbon**+0.5% **vermicompost** (m/m)
PV1	Soil + 1 % **carbon**+1% **vermicompost** (m/m)
PV2.5	Soil + 2.5 % **carbon**+2.5% **vermicompost** (m/m)
PM0.1	Soil + 0.1 % **carbon**+0.1% **manure** (m/m)
PM0.5	Soil + 0.5 % **carbon**+0.5% **manure** (m/m)
PM1	Soil + 1 % **carbon**+1% **manure** (m/m)
PM2.5	Soil + 2.5 % **carbon**+2.5% **manure** (m/m)

Results – summary on the effects of plasmalysis-derived carbon

- No changes in analysed soil characteristics
- 1% carbon increase shoot biomass by 114 % on soil Grabenegg
- 1% carbon increased chlorophyll content by 60 % on soil Grabenegg
- Increase in total phosphorus (P) content in maize shoots
- Increase in nitrogen (N) concentrations in maize shoots
- Increase in plant P and N potentially due to carbon-induced mobilization in soil

Earthworm avoidance test



- No response in earthworm behaviour in application rates of up to 1%
- Avoidance only found in high application rates of 2.5%

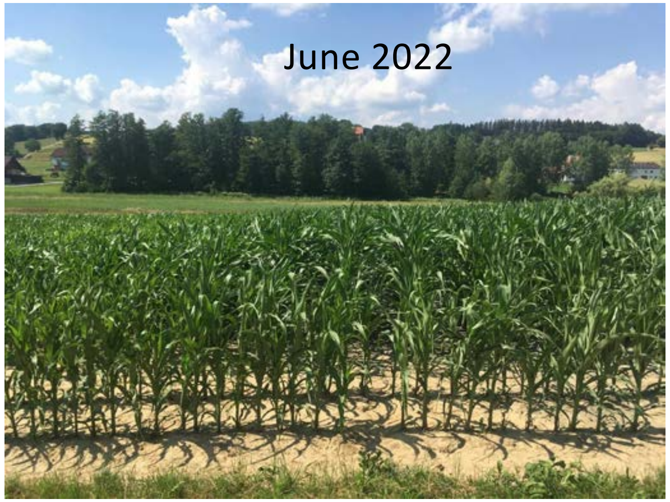
Field experiment Grabenegg


April 2022


26. 8. 2022


April 2022

May 2022


June 2022

„Super Carborator“

Conclusions

- Carbon from methane plasmalysis has potential for use in agriculture.
- There was no effect on soil pH and water holding capacity in the short term
- Plasmalysis-derived carbon lead to increased maize biomass on one particular soil.
- Plasmalysis-derived carbon could be applied on soil in combination with nutrient-rich organic material (e.g. manure, compost) in pelletized form.

The next steps

- Evaluation of the first field experiments
- Mixture of carbon with organic material mixtures (vermicompost and manure)
- Pelletisation of the carbon for simplified and safe application to the field
- Optimization of carbon properties especially considering water holding capacities

Thanks for your attention!