Biochar : Production and testing in small-scale use

SIE project at SKIL, EPFL

Mario Gall

Project overview

- Produce biochar in a simple way
  - Stove construction
  - Pyrolysis of organic waste and wood
- Test the fertilization capacity of biochar
  - Growth of Spinach and Radish
  - Comparison to compost fertilization and no fertilization
  - Production of a timelapse video of the radish growth

What is biochar?

"The solid product of thermal decomposition of organic matter at a temperature below 900°C under conditions of oxygen deficit"

(Godlewska et al. 2017)

= a stable form of organic matter

- Rich in nutrients
- Slowly degradable
- Porous with a large surface area

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Difference to fresh organic matter

- Long-term fertilizing effect
  - Reduced risk of leaching into the groundwater
  - No "fertilization peak" at the moment of application, but rather a constant effect
- Improved soil properties
  - Better water retention
  - Increased ion exchange
  - Favorable structure for microorganisms

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= a stable form of organic matter

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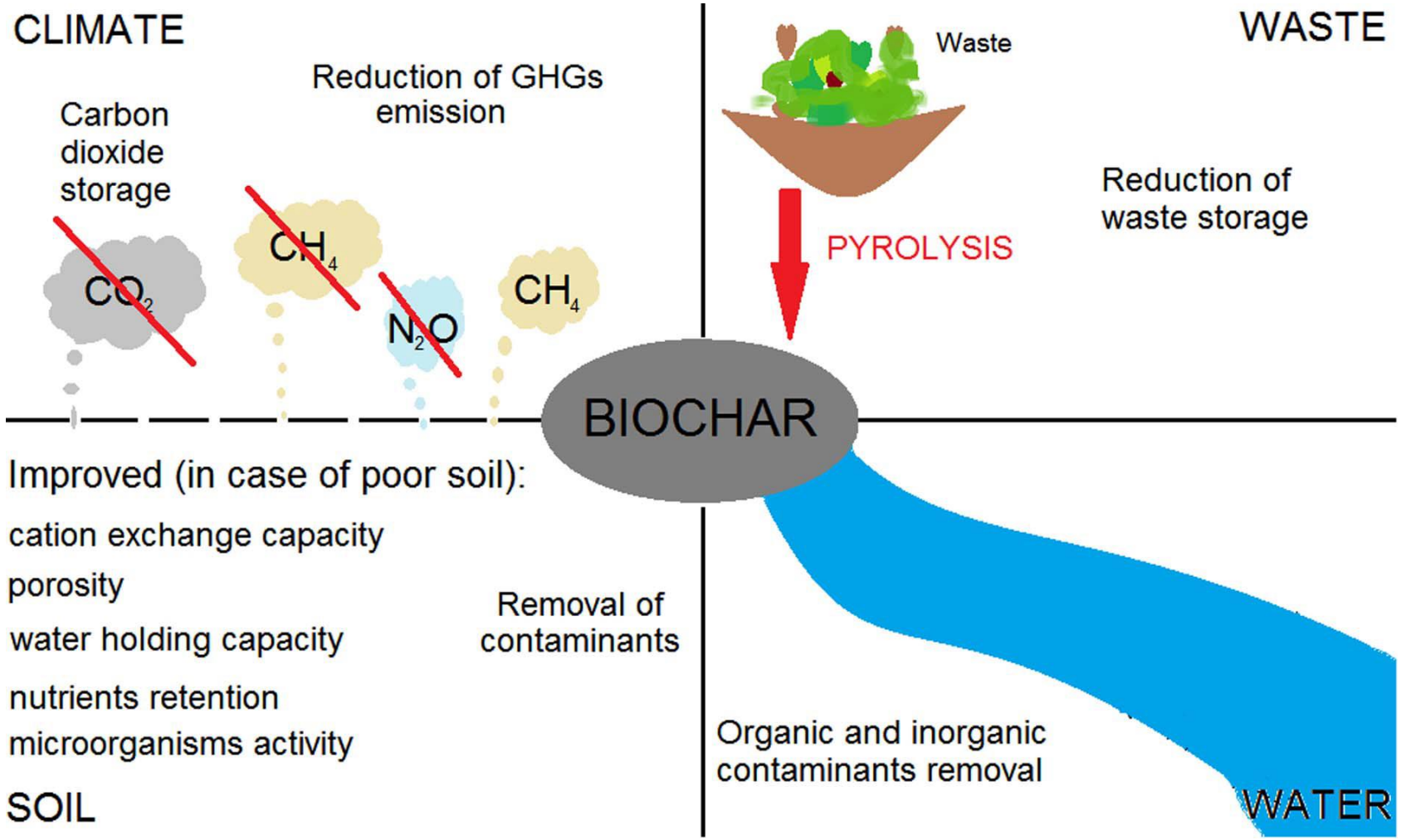
Difference to compost

- Long-term fertilizing effect
  - Nutrient-stabilizing matrix (even more than in compost)
- Improved soil properties
  - Better water retention
  - Increased ion exchange
  - Favorable structure for microorganisms

Why do we need biochar?



(Godlewska et al. 2017)

Part I: Stove construction

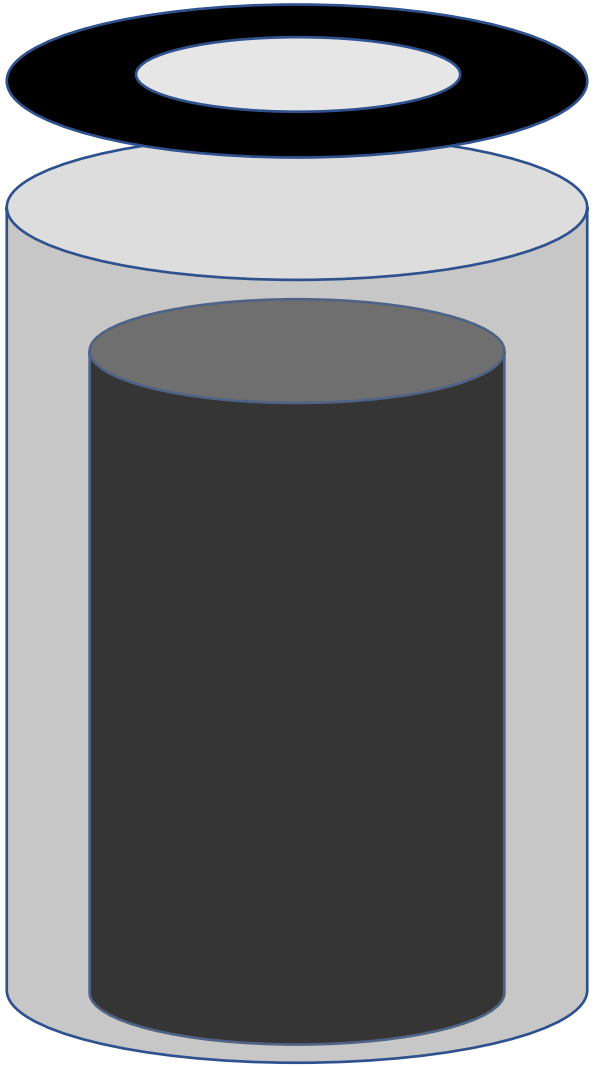
Concept: «Dome school biochar stove»

Original – 1.4L
(Kelpie Wilson 2010)

Upscaled version – 200L
(Kristen Brandley 2013)

My version – 20L

Stove construction



Lid with a central hole:
Balance between air flow and heat retention

Inner can aeration: Escape pathway for pyrolysis gases

Zone of wood burning

Zone of biomass pyrolysis

Bottom aeration:
Perforated inner can, large holes in outer can

Stove performance

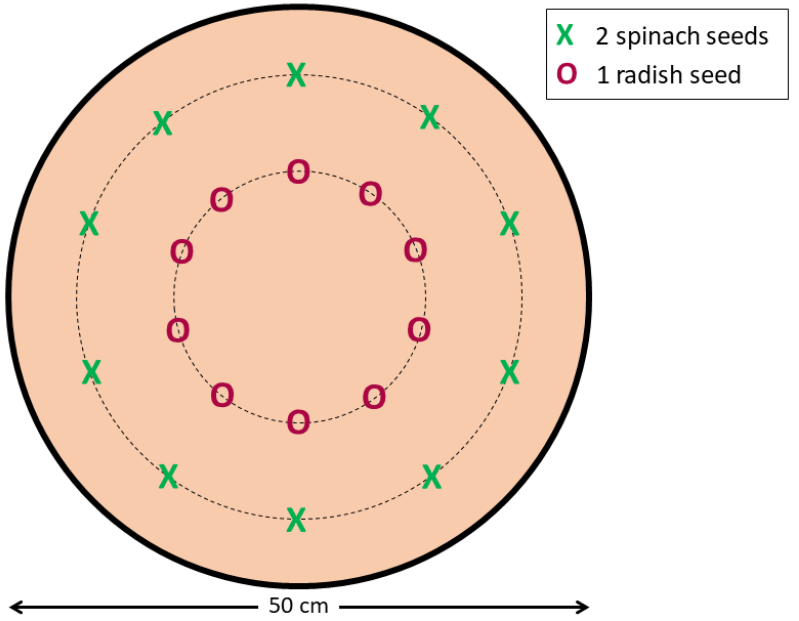
- Simple construction
- Easy to use
- It works
- Can also be used as a grill

- Low temperature
- Too much oxygen
  → Incomplete and heterogeneous pyrolysis
  → Big fuel (wood) requirement

Part II: Vegetable cultivation

Comparative approach: Biochar vs. Compost vs. Control

- Cultivate radish and spinach (spring crop)
- Same growth conditions (light, irrigation, pot size, sowing, …)



Growth analysis

Initial idea

- Leaf fluorescence
- Porous exchange
- Soil moisture
- Soil ion exchange capacity
- Harvest comparison

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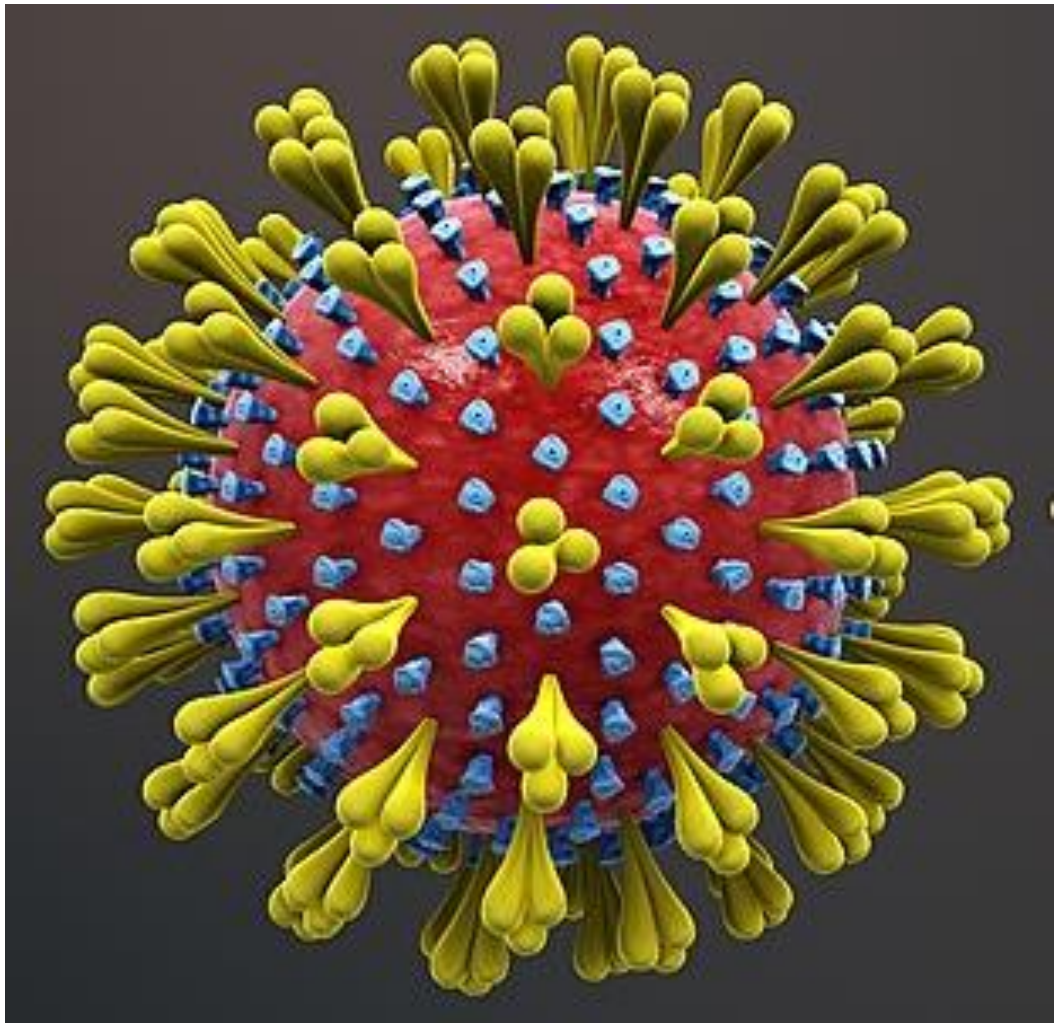
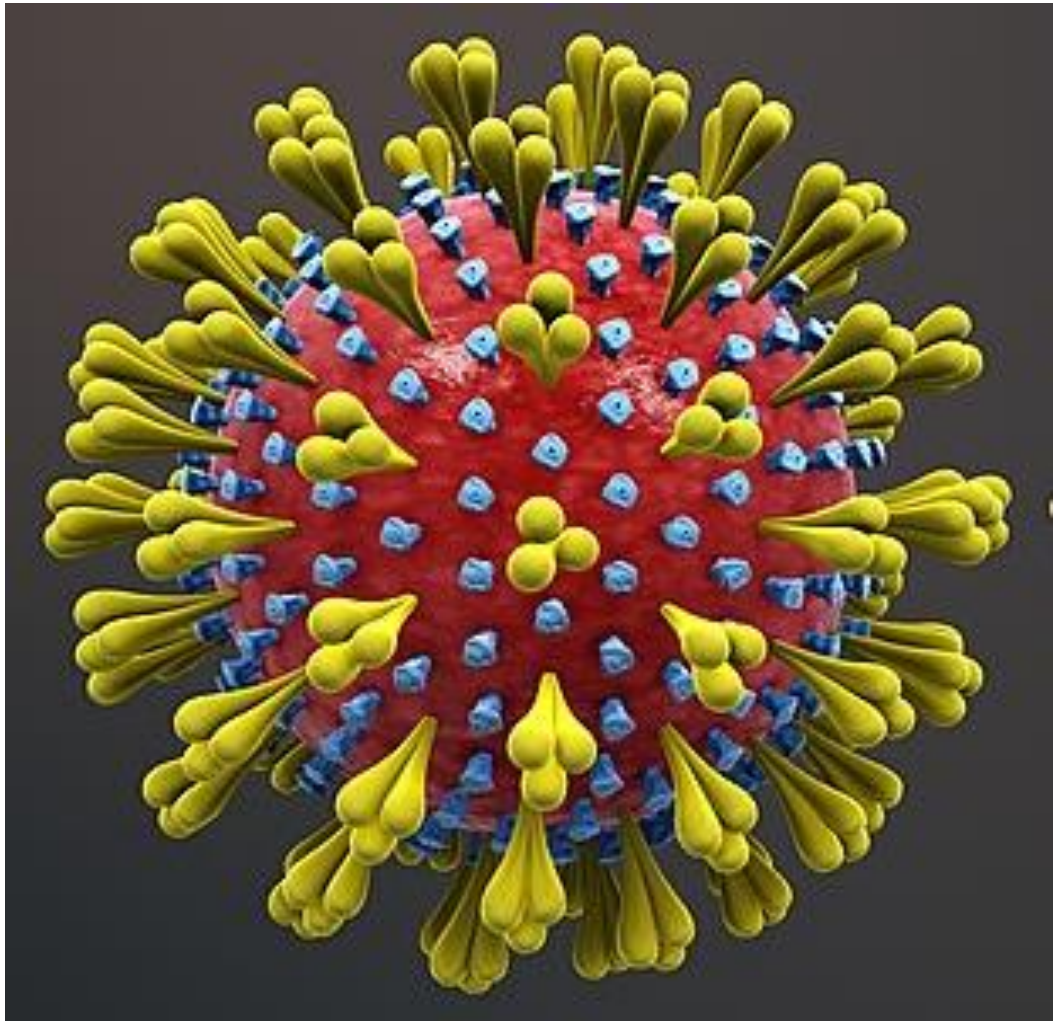


Growth analysis



Adapted approach

- Harvest comparison
- Timelapse video of growth

→ Focus only on productivity improvement!

Results

EPFL

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Mario Gall

Supervised by

Anders Meibom
Samuel Cotture

SIE Project at SKIL, EPFL

Spring semester 2020

Results

Control Biochar Compost

Sowing:
March 4

March 21

March 30

Results

April 11

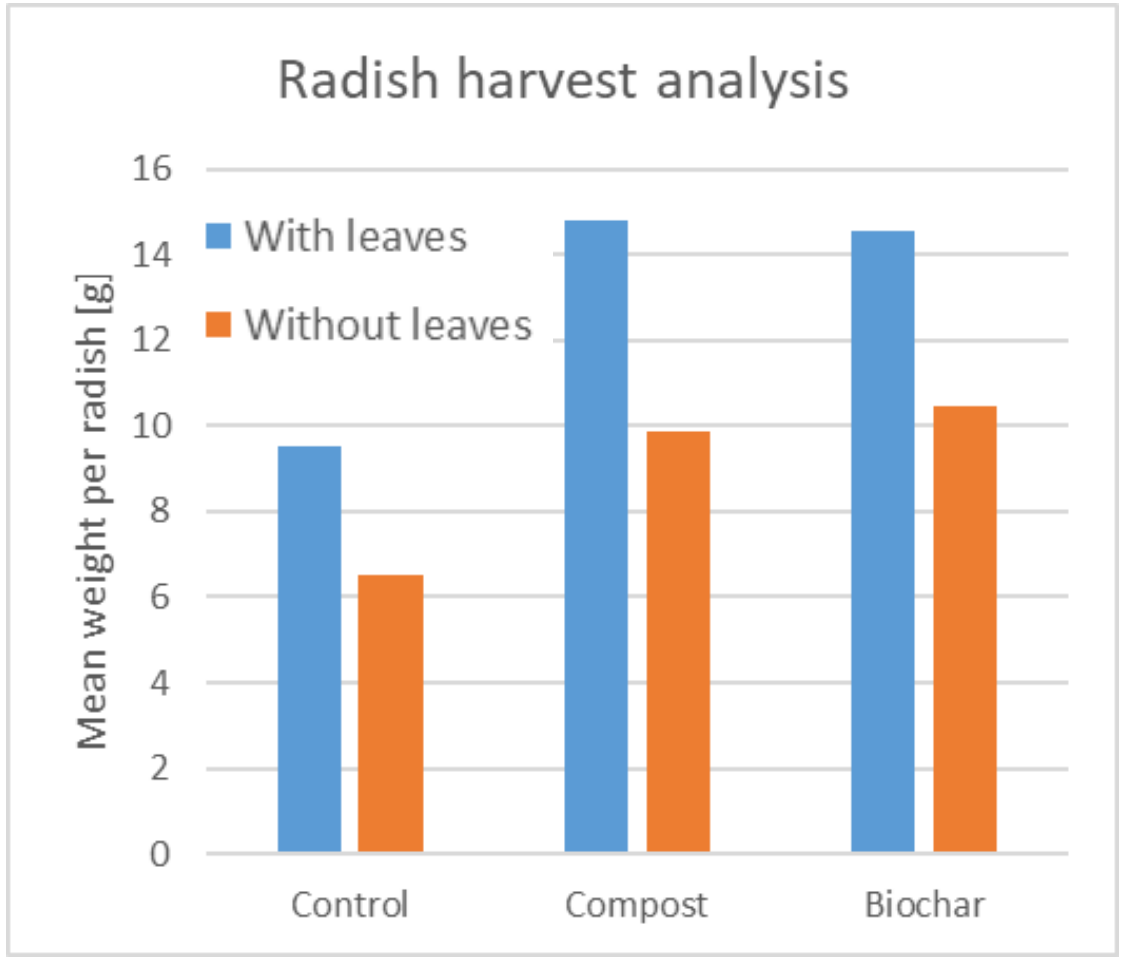
April 17 (harvest)

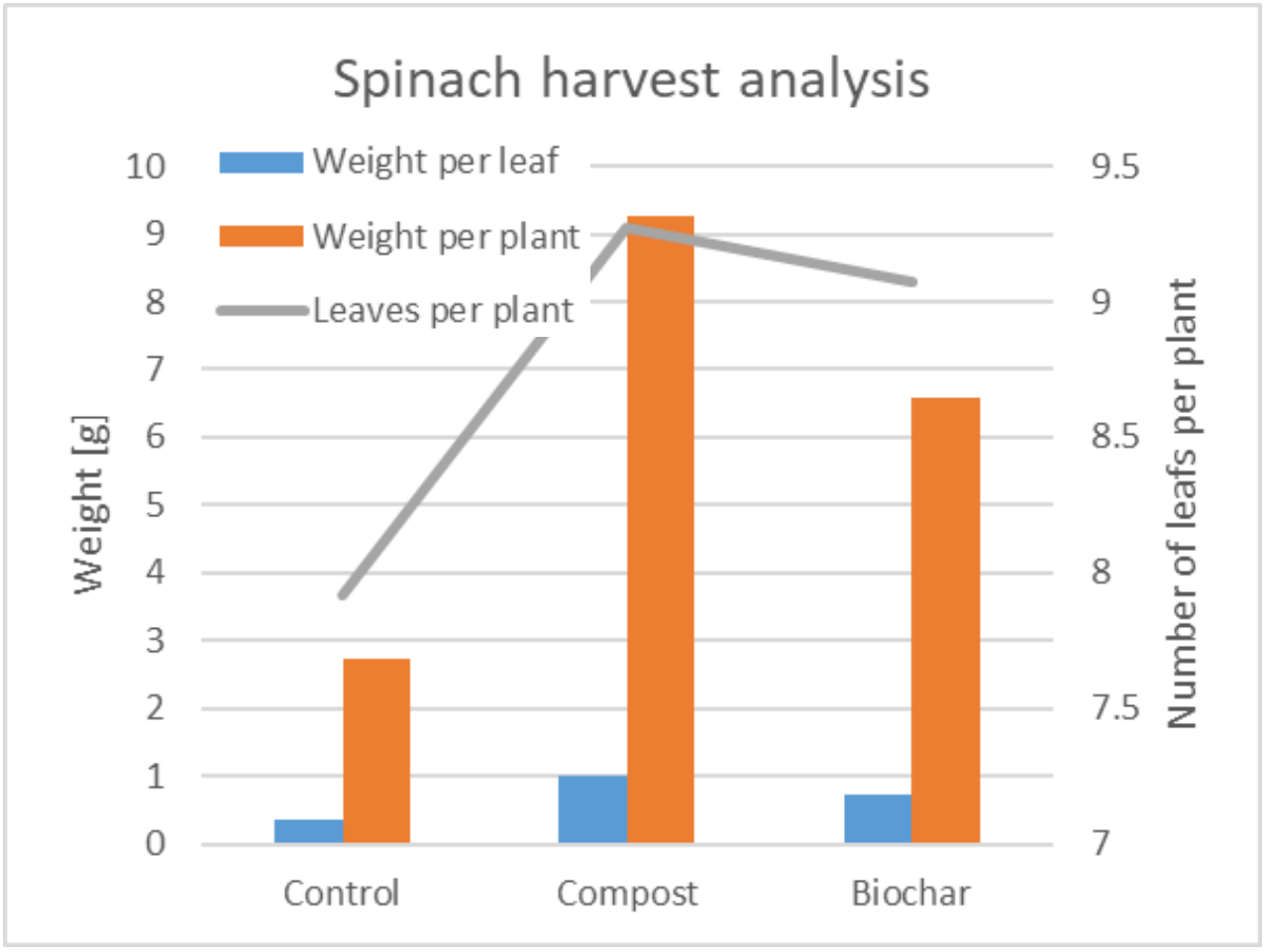
Control

Biochar

Compost

Results


Radish harvest analysis
Mean weight per radish [g]
16
14
12
10
8
6
4
2
0
With leaves
Without leaves
Control
Compost
Biochar


Spinach harvest analysis
Weight [g]
10
9
8
7
6
5
4
3
2
1
0
Weight per leaf
Weight per plant
Leaves per plant
9.5
9
8.5
8
7.5
7
Number of leafs per plant
Control
Compost
Biochar

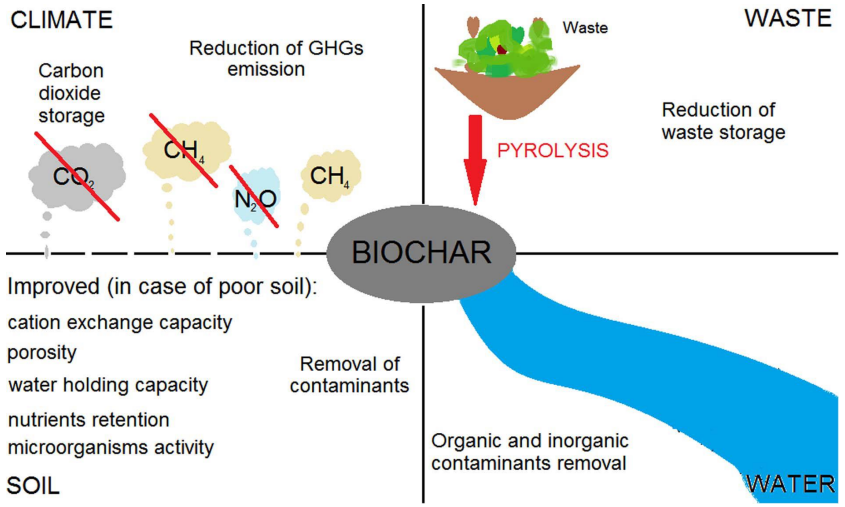
Result discussion

- Radish: Same result for compost and biochar
  - Cultivation for 44 days
  - Control leads to much smaller radish
- Spinach: Victory for the compost!
  - Cultivation for 61 days
  - Biochar improves growth, but not as much as compost

→ Biochar addition results in considerable improvement of soil fertility without being the outstanding solution.

Result discussion: Improvements

- Low significance
  - No replicates (logistics)
  - No measurements during the growth phase
- Neglect of other aspects of biochar addition
  - Productivity improvement is only one aspect
  - Soil improvement?
  - Sustainable cultivation?
  - Environmental impact?
  - …



Conclusion

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- Stove: Works, but not optimal
  - Low temperature, too much O2
  - High fuel consumption
  - → Space for improvement, but good as a first solution
- Biochar: Good fertilizer
  - Very interesting topic
  - More research required
  - Long-term effects to be studied

Conclusion – future scope

- Pots will hopefully remain available
  - Interest from Campus durable
  - Storage at “Ferme de Bassenges”?
- Many possible topics to be studied
  - Cultivation of other crops, during other cropping seasons
  - Long-term effect: same experiment every year
  - Soil analysis: Nutrient depletion, water retention, …
  - Effect of different biochar loads
  - …

Thanks for listening!

I hope you liked it as much as I did

Questions?