Acid activation increases plant P availability from P-rich biochars and ashes

Clara Kopp, Pietro Sica, Dorette Müller-Stöver, Lars Stoumann Jensen
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New bio-based fertilisers from organic waste upcycling.

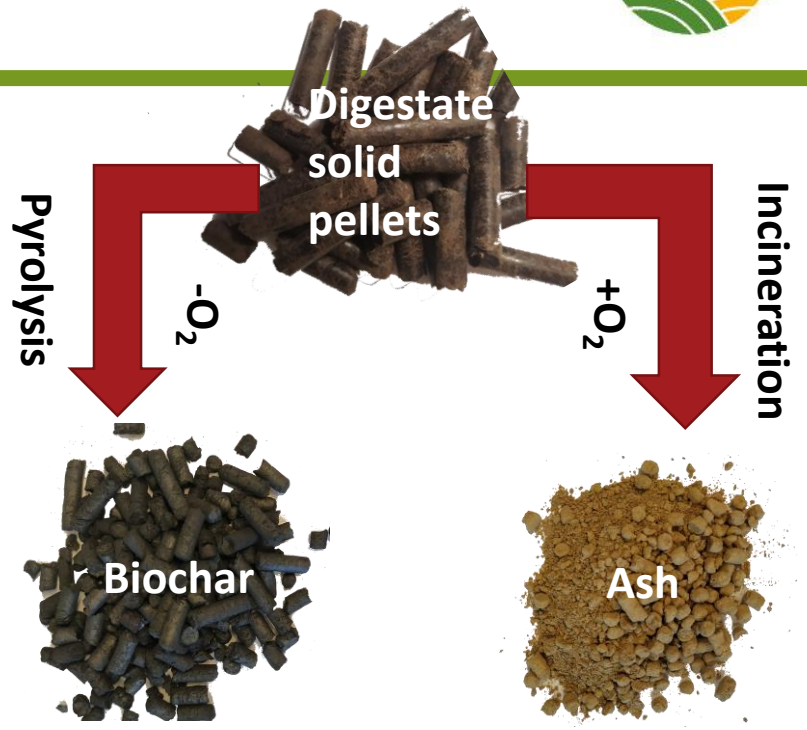
"This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.860127"

FertiCycle

Thermal treatment of P-rich wastes

Thermal treatment of phosphorus rich organic wastes

- ✓ Volume reduction & increase in P concentration
- ✓ Removal of organic and microbial pollutants
- ✓ Potential energy production
- ✓ With pyrolysis: potential for carbon sequestration



Often **low P availability from biochars and ashes** depending on feedstock, temperature during thermal treatment, soil pH and texture.

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Acid activation as a potential pretreatment?

- crystalline, insoluble compounds during thermal treatment
- Ca-phosphates or Al and Fe phosphates

→acid soluble compounds

Is acid activation a potential low tech solution?

Objective:

Test **sulfuric acid activation** as an approach to **increase plant available phosphorus** from different biochars and ashes and compare the response of different biochars and ashes to acid activation.

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Biochars & ashes

Sewage sludge char (SS-C)

Manure digestate char (DS-C)

Meat and bone meal char (MB-C)

Insect frass char (IF-C)

Sewage sludge ash (SS-A)

Manure digestate ash (DS-A)

Poultry litter ash (PL-A)

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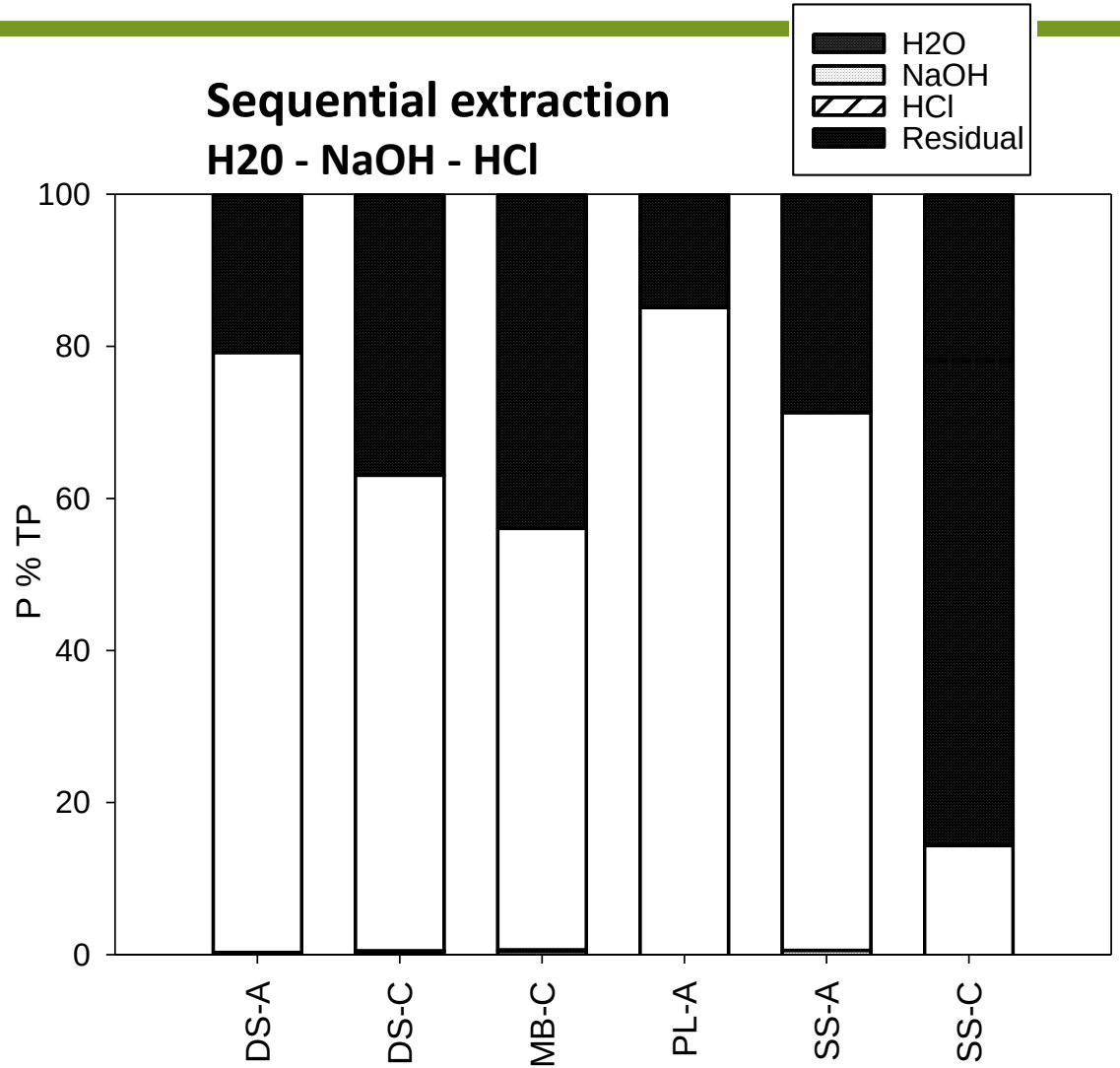
Material properties

Material	pH	C (%)	P (mg / g)	WEP (% Total P)
Digestate ash	10.8	0.4	81.3	0.0
Digestate char	11.2	54.9	26.6	0.2
Insect frass char	10.9	60.1	36.5	1.7
Meat/bone char	11.2	30.5	106.9	0.3
Poultry litter ash	12.4	1.2	57.5	0.2
Sewage sludge ash	8.6	0.2	96.3	0.0
Sewage sludge char	7.2	18.1	69.8	0.0



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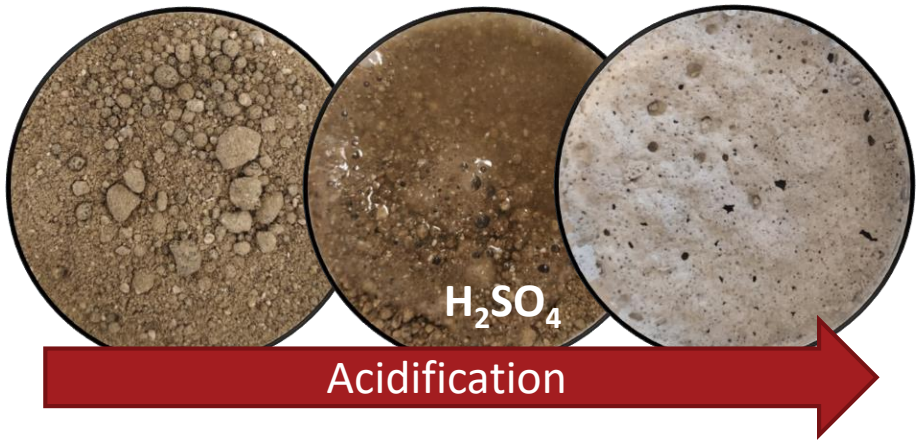
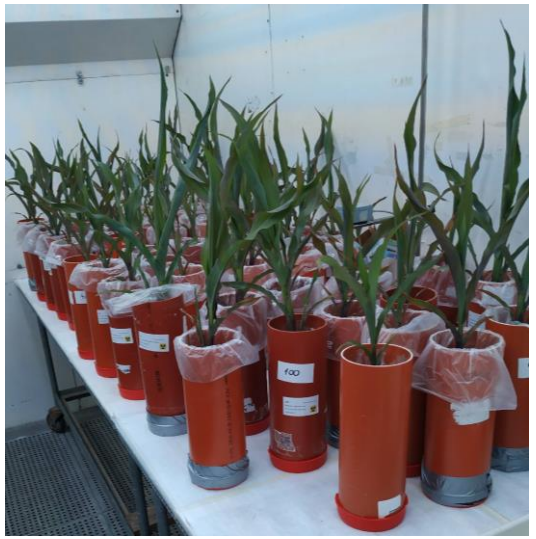
Acid activation & Pot experiment

- Mixing materials with 2.5 – 10 M of sulfuric acid
- material to acid ratio of 2:1
- Drying at 60° C
- pH and WEP in relation to M H_2SO_4 applied

→ Molarity to achieve WEP of ≈ 50 % initial P



- Materials crushed and sieved (2 mm)
- 80 mg P applied / kg soil
- Maize grown until 40 DAS



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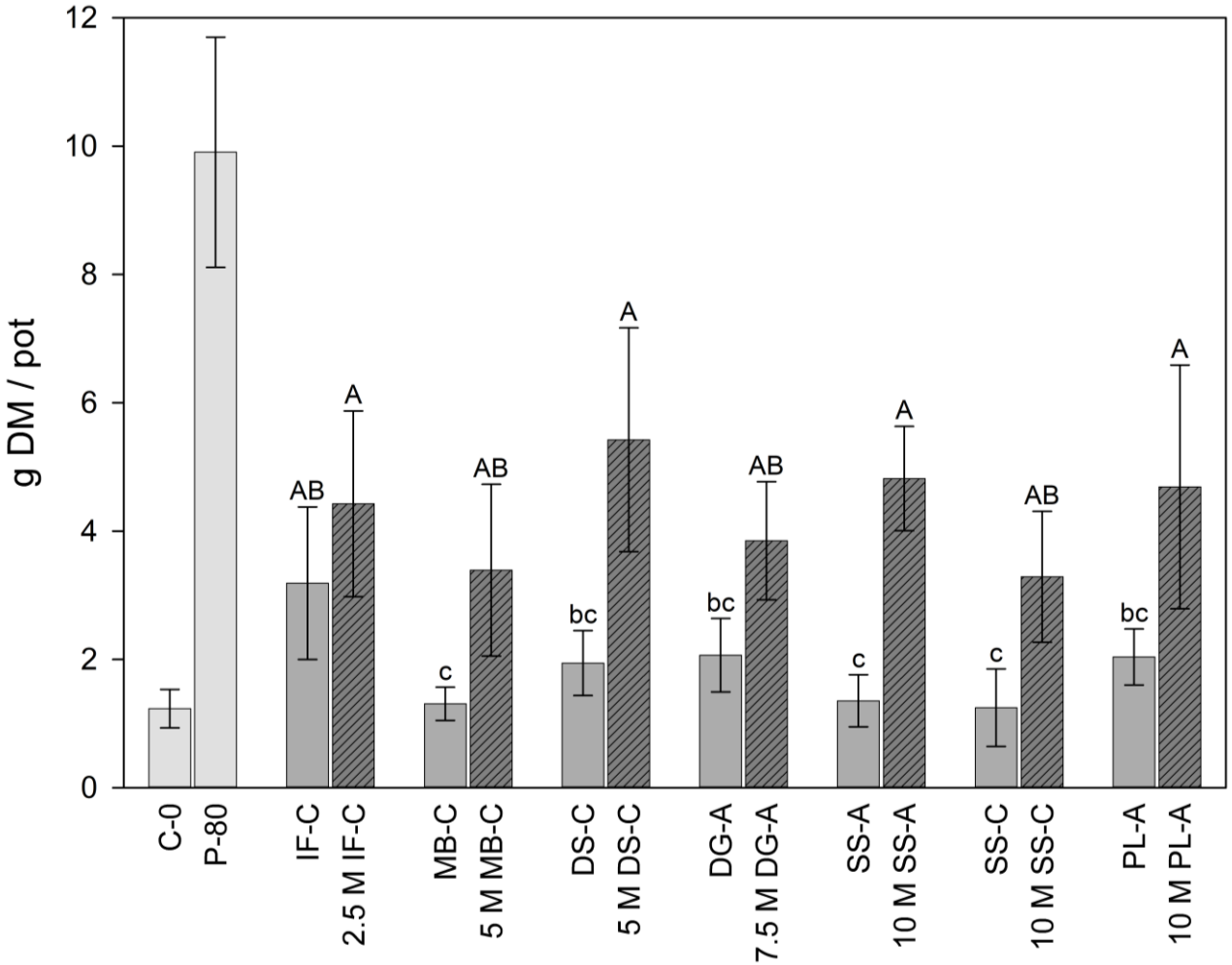
Shoot biomass



DS-C Untreated **DS-C Activated**

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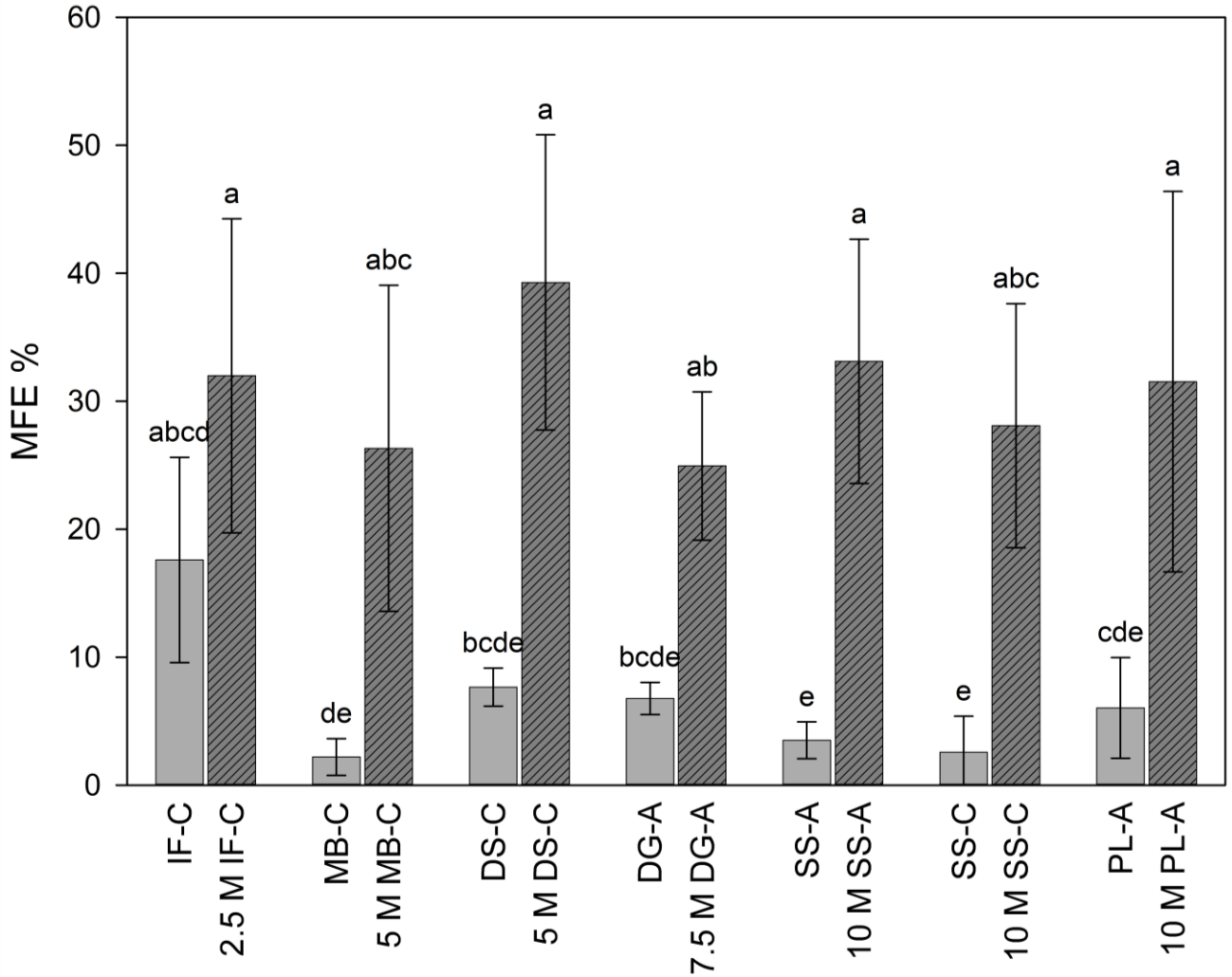
Mineral phosphorus fertilizer equivalent



- Potential to replace substantial amounts of mineral P fertilizer with acid activated materials

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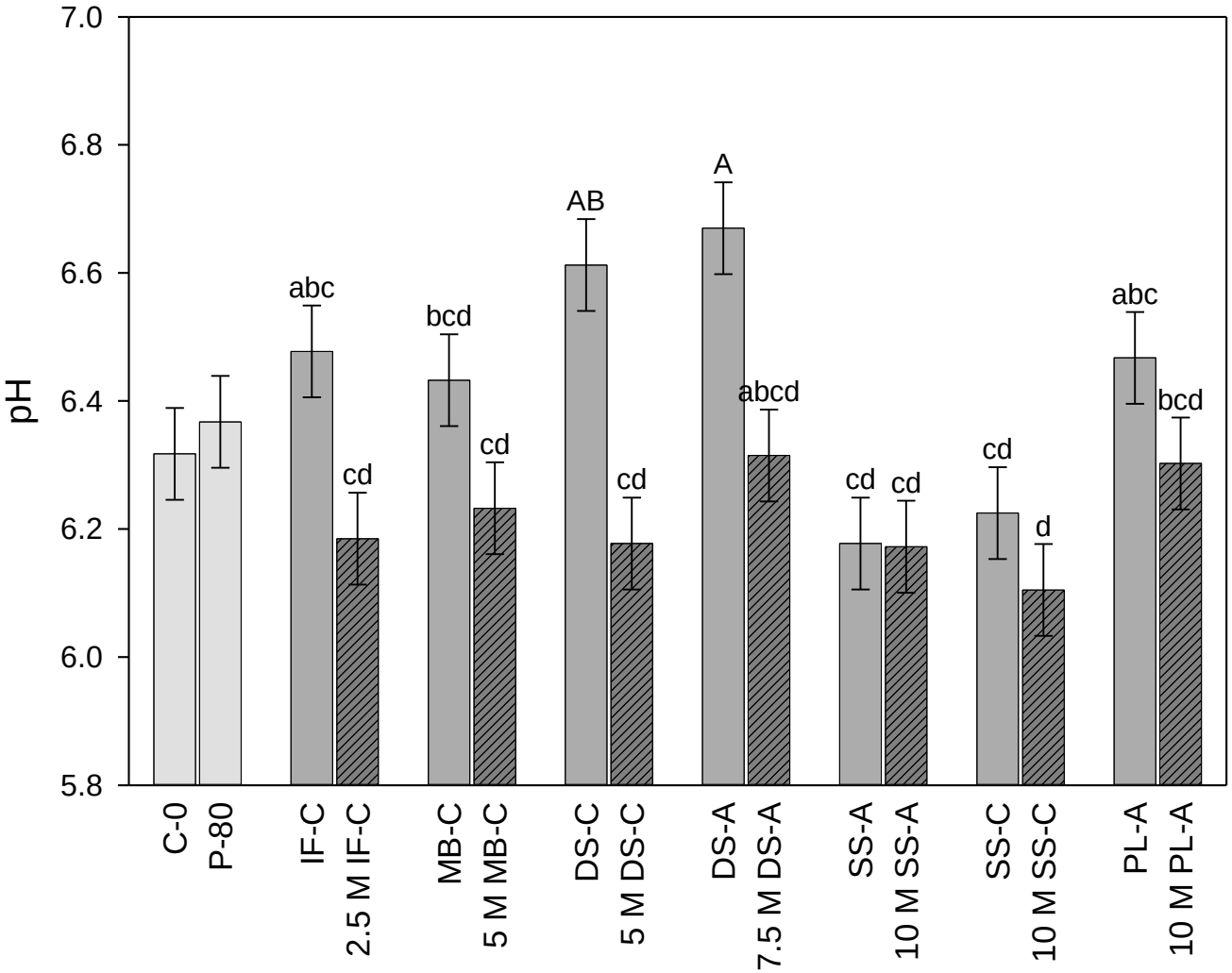
Soil pH at the end of the experiment

Material	pH
IF-C	2.4
MB-C	3.5
DS-C	1.8
DS-A	5.8
SS-A	3.3
SS-C	1.4
PL-A	3.0



- Soil pH not decreased compared to control with acid activated biochars
- Acid activation eliminates the liming effect of some ashes and biochars (Especially the digestate materials)

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Conclusions

- Most untreated biochars and ashes have in the short-term a very low fertilizer replacement value
- Shoot biomass and P uptake ↑ with acid activation
- Soil pH →

→Acid-activation is a potential pre-treatment method to increase plant P availability.

- **Meat and bone meal biochar and digestate biochar** require **lower acid inputs** to achieve an effect on P availability
- Plant P availability of **poultry litter ash and sewage sludge biochar/ash** can be increased, but only with **higher acid inputs**

→Amount of acid required differs and depends on biochar/ash.

Further experiments on biological acidification, long-term release of P, heavy metal availability and carbon stability

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Thank you for your attention!

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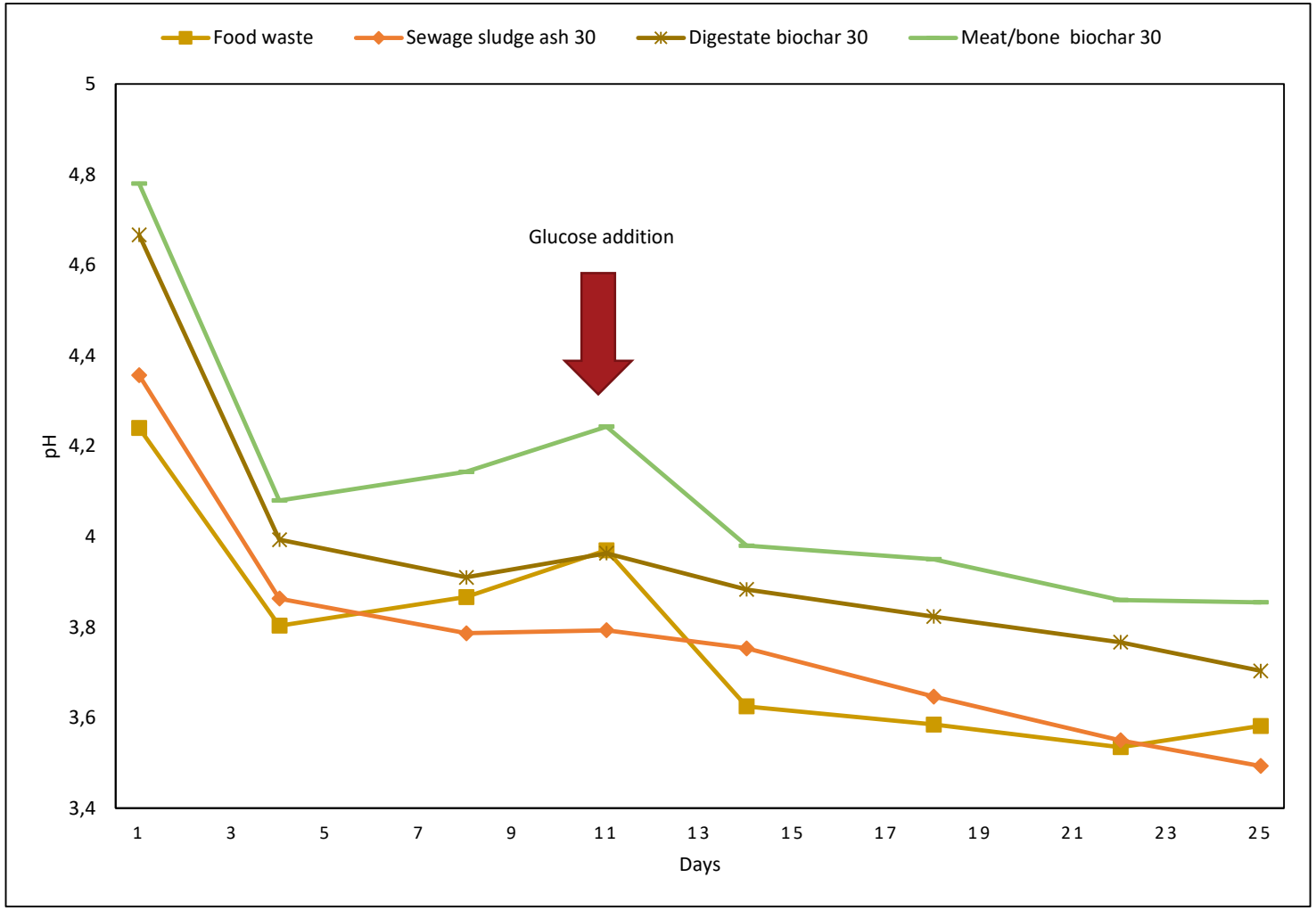
Biological activation



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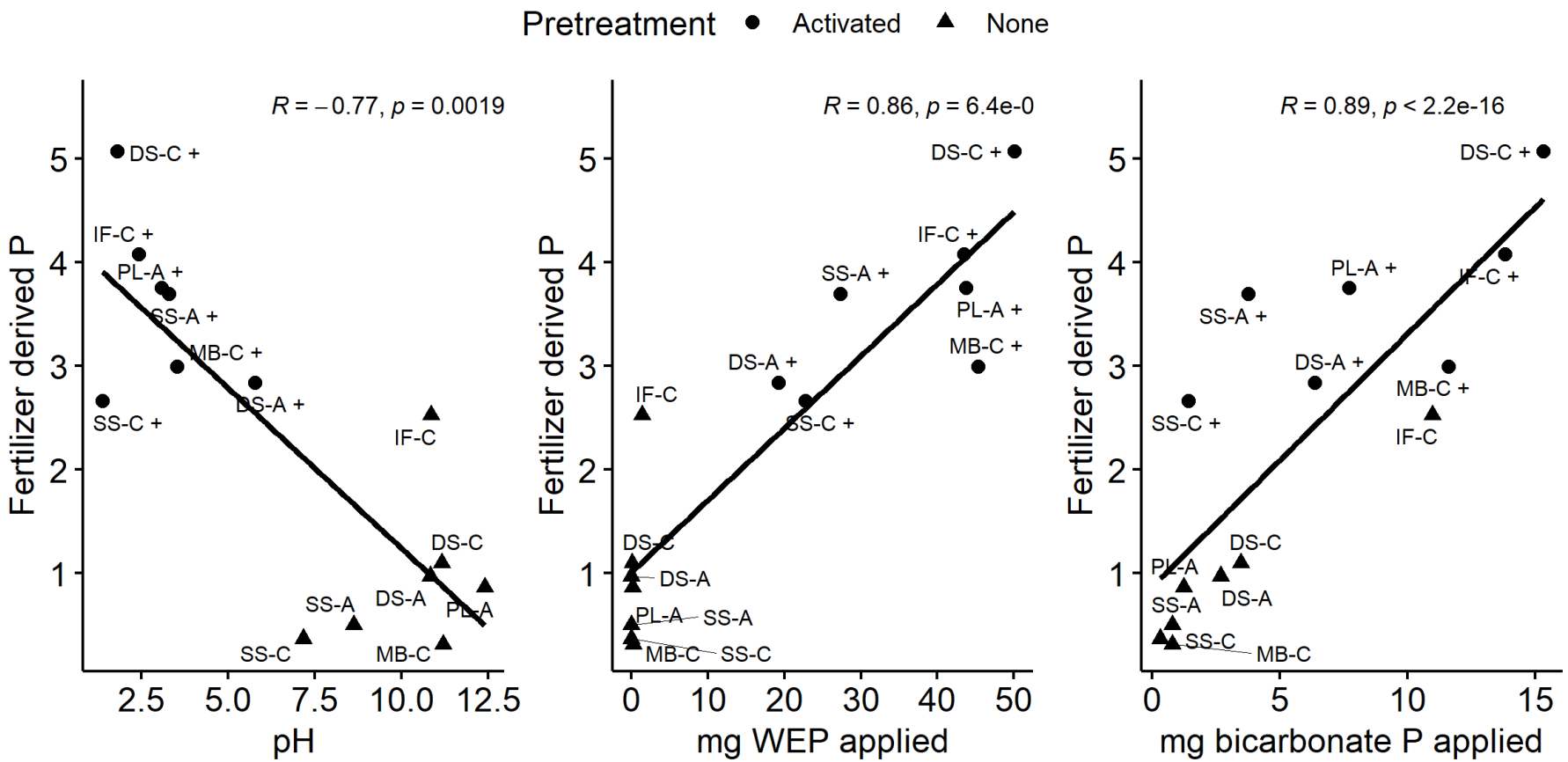
Correlations



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