Optimising Use and Application Methods of Waste and Biobased Fertilisers

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Introduction

Background:

- **Smart use** of P-rich biowastes is an alternative **to reduce** the **dependence** on **non-renewable** P sources.

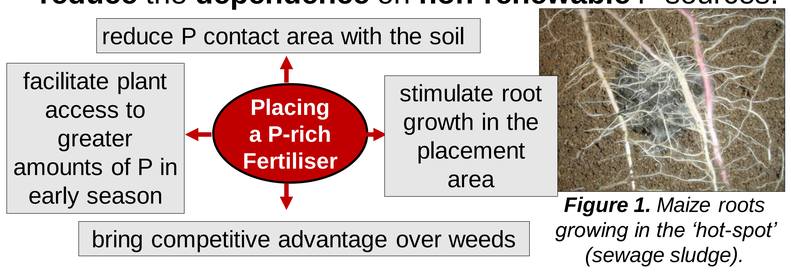


Figure 1. *Maize roots growing in the 'hot-spot' (sewage sludge).*

The placement of **mineral P** fertiliser can **increase** maize **biomass** and P uptake. **However**, this has **not** been **observed** for placement of **biomaterials.**

Hypotheses for placement of biomaterials:

1) to **be more efficient**, **pre-treatments** to **increase** the **P** availability in the **rhizosphere** may be needed;
2) may imply an **opportunity cost** for that plant on **exploring the soil resources** (less roots in the bulk soil). Thus, the 'hot-spot' should deliver sufficient nutrients to **overcompensate** it and favour plant growth.

Incubation Experiments

Effects of Chemical Pre-treatments on Biomaterials' P Availability and Dynamics in the Soil.

- **Biomaterials:** sewage sludge (SS), SS ash, meat bone meal (MBM), biogas fiber (BGF).
- **Treatments:** Addition of H_2SO_4, NaOH, $Ca(OH)_2$.
- Biomaterial layer between two low-P soil columns.
- Measurement of water extractable P (WEP) in soil in slices of 0-1, 1-2, 4-5, 6-7 mm distance from biomaterial layer.

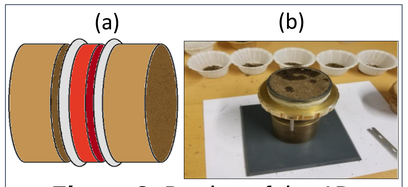


Figure 2. *Design of the 1D slicing approach (a) used to assess the effects of chemical treatments on the P diffusion in the soil. Slicing device (b).*

	Changing on water extractable P			Effects on the P diffusion in the soil *		
Chemical:	H_2SO_4	NaOH	$Ca(OH)_2$	H_2SO_4	NaOH	$Ca(OH)_2$
Concentration:	1.5 M	1.5 M	30%	1.5 M	1.5 M	30%
SS	30%	20%	0%	++	+++	-
SS ash	30%	**20%**	3%	+	**++++**	same
MBM	**80%**	15%	-4%	**++++**	+	---
BGF	75%	20%	-15%	+	++	-

*each +/- indicates a significant increase/decrease of 100 mg of P/kg of soil in each distance compared to untreated material

Incubation Experiments – Main Findings

- In **SS** and **SS ash**, **acidification** increased WEP **more** than addition of **NaOH**. However, **diffusion** was **greater** from the **NaOH-treated** materials
- **$Ca(OH)_2$** reduced or had **no effect** on WEP and P diffusion.
- **MBM and BGF**: **H_2SO_4** increased WEP to a **greater** extent than **NaOH.**

Pot Experiments

Study 1: Wheat P uptake and growth response to the placement of acidified biomaterials.

- **7 Biomaterials:** 3 SS, MBM, MBM pellets, BGF, BGF pellets.
- **3 treatments:** untreated (mixed or placed), acidified placed.
- Indirect labelling with 33P to trace the P uptake from the biobased fertilisers.

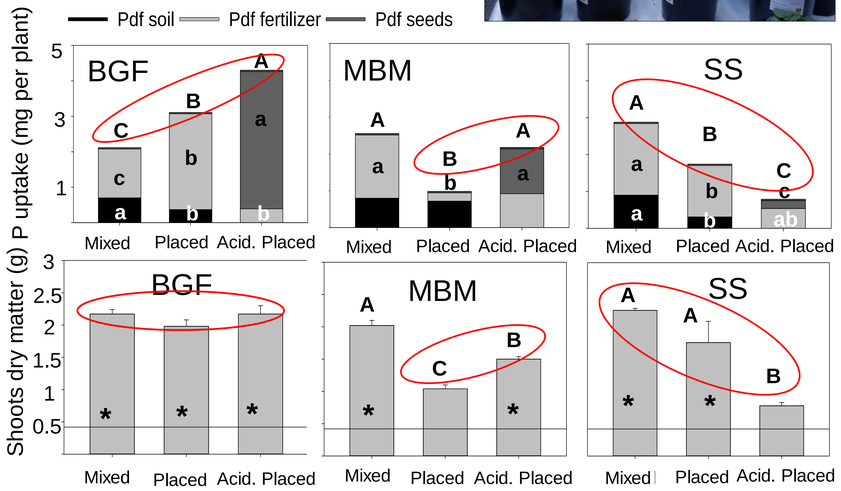
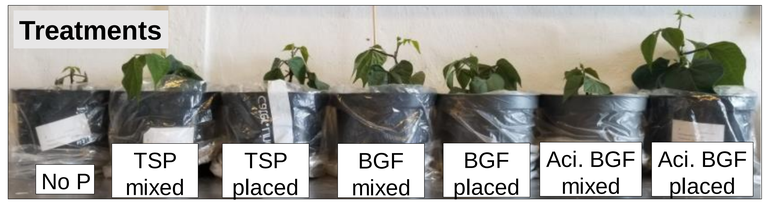


Figure 3*. Effects of the placement of acidified BGF, (MBM) and SS on wheat P uptake (above) and shoots dry matter (below). *significantly greater than 0 P treatment (solid line). Pdf = P derived from fertilizer; BGF = biogas fiber; MBM = meat and bone meal; SS = sewage sludge*

Study 2: Effects of the Placement of Acidified Biogas Fiber on the P uptake and biomass of 10 horticulture crops*.



**The main findings of this study are highlighted in the next section.*

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

FertiCycle

Pot Experiments – Main Findings

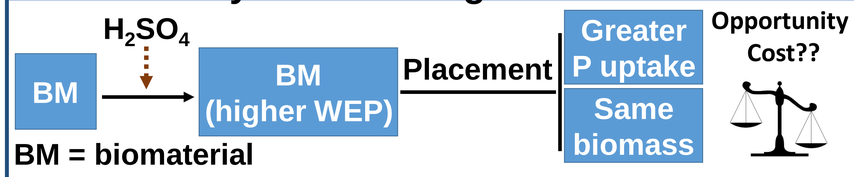
Study 1:

- The placement of **acidified SS inhibited** wheat growth and **reduced** P uptake.
- For **MBM**, P uptake was comparable in the **mixed and acidified placed** treatment, but this was not reflected in plant biomass
- The **placement** of acidified BGF more than **doubled** the P uptake compared to the mixed treatment. However, it **did not increase plant growth**

Study 2:

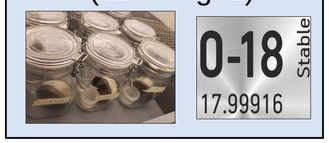
- Placement significantly increased:
  - **P uptake of 7** of 10 crops: carrot, bean cucumber, fennel, onion, squash, and tomato.
  - **Biomass of 3 crops**: bean, carrot, and onion.
  - For **4 crops**, placement **increased P uptake** but did **not lead to an increase in biomass.**

Summary of Screening Studies Results

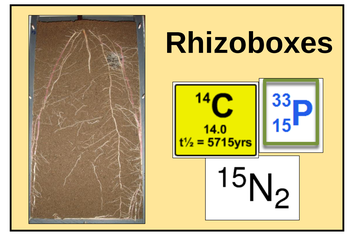


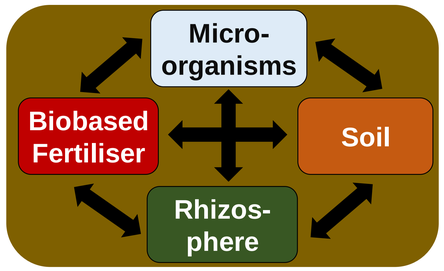
Current Studies and Expected Outcomes

Incubation
(as in Fig. 2)



Integrating **isotopic labelling** methods with **incubation** (18O) and **rhizobox** (14C, 15N, 33P) studies, to **elucidate interactions** in the placement area.





Based on these results, we expect to:

- **Optimize** the match between **crop demand** and **fertilizer nutrient release → compensate opportunity loss.**
- Formulate a **biobased fertiliser to be placed in horticulture systems, replacing mineral P** fertiliser.
- Open **opportunities** for **studying bioacidification** approaches to develop an **organic fertiliser**.