

MicroBeTech 2025

27-29th may 2025, Ljubljana, Slovenia

POSTER

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MICROBIAL CONSORTIA AND INOCULATION TECHNIQUES

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Proyecto BIOSYSMO GA 101060211



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OPTIMIZING METAL PHYTOREMEDIATION BY *PHRAGMITES AUSTRALIS* THROUGH PGPR-BASED MICROBIAL CONSORTIA AND INOCULATION TECHNIQUES

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INTRODUCTION

Phytoremediation is a sustainable strategy that uses plant systems to remove pollutants—particularly metal(loid)s—from contaminated soils and water. *Phragmites australis* is a resilient species capable of accumulating metals in its root system through rhizofiltration. However, *P. australis* exposure to high xenobiotic levels of metal(liod)s can induce stress, compromising plant growth and reducing phytoremediation efficiency. Plant growth-promoting rhizobacteria (PGPRs) can mitigate these effects, enhancing plant resilience and metal uptake.

Recent advances have highlighted the importance of using **microbial consortia** instead of single strains to achieve more robust and synergistic effects in plant–microbe interactions. In this study, we developed a bacterial consortium from PGPR isolates associated with *P. australis* and applied the **iACME aggregation** method to generate encapsulated microaggregates.

OBJECTIVES

- To **isolate** rhizobacteria capable of establishing interactions with *P. australis* in environments contaminated with metal(loid)s.
- To **characterize** the isolated rhizobacteria for potential PGPRs traits, evaluating traits such as siderophore production, phosphate solubilization, IAA synthesis, or ammonia production.
- To create different **bacterial consortia** using the **iACME aggregation** method under anaerobic and aerobic conditions.
- To **select** the most promising consortia for mesocosm-scale experiments based on phenotypic traits and functional performance in microcosm experiments.

METHODOLOGY

- Rhizobacteria were isolated from both **epiphytic and endophytic** fractions of *P. australis* roots growing in metal-contaminated environments. Isolates were screened for PGPRs traits.
- **Three inoculation methods** were tested: **soil, root inoculation** of 30-day-old seedlings under controlled conditions, and **seed inoculation**. Plant growth parameters such as height, leaf number, and biomass were recorded to evaluate performance.
- A **standardized consortium of the 30 bacterial isolates** (equal cell density) was used to form iACME microaggregates. Seedlings 30-days-old seedlings were transplanted into sterilized microcosms, inoculated via soil with different consortia, acclimated for 10 days, then exposed to contaminated water for 15 days. Plant phenotypic traits were monitored to evaluate consortium effectiveness.

Bacterial Isolation

Regime Exposure	Number of Epiphytic Bacteria	Number of Endophytic Bacteria	Total
Control Exposure	8	6	14
Acute Exposure	3	2	5
Chronic Exposure	5	6	11
Total	16	14	30

Table 1. Number of bacterial isolates according to their origin and method of exposure to contaminated water in *Phragmites australis*.

RESULTS

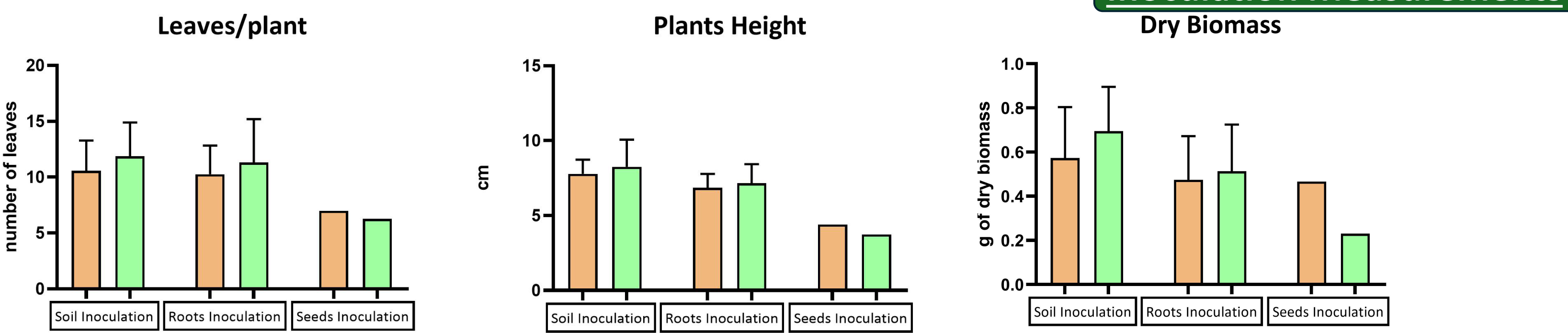
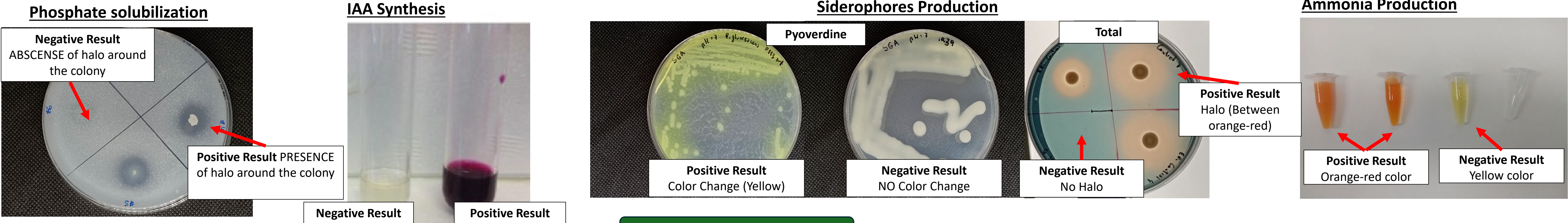


Figure 1. Results of the number of leaves per plant, height, and dry biomass as a function of each inoculation method used. In each of the graphs, the orange color indicates the results for the control, while the green color indicates the results for each inoculation method.

PGPR Traits



Consortia Experiment

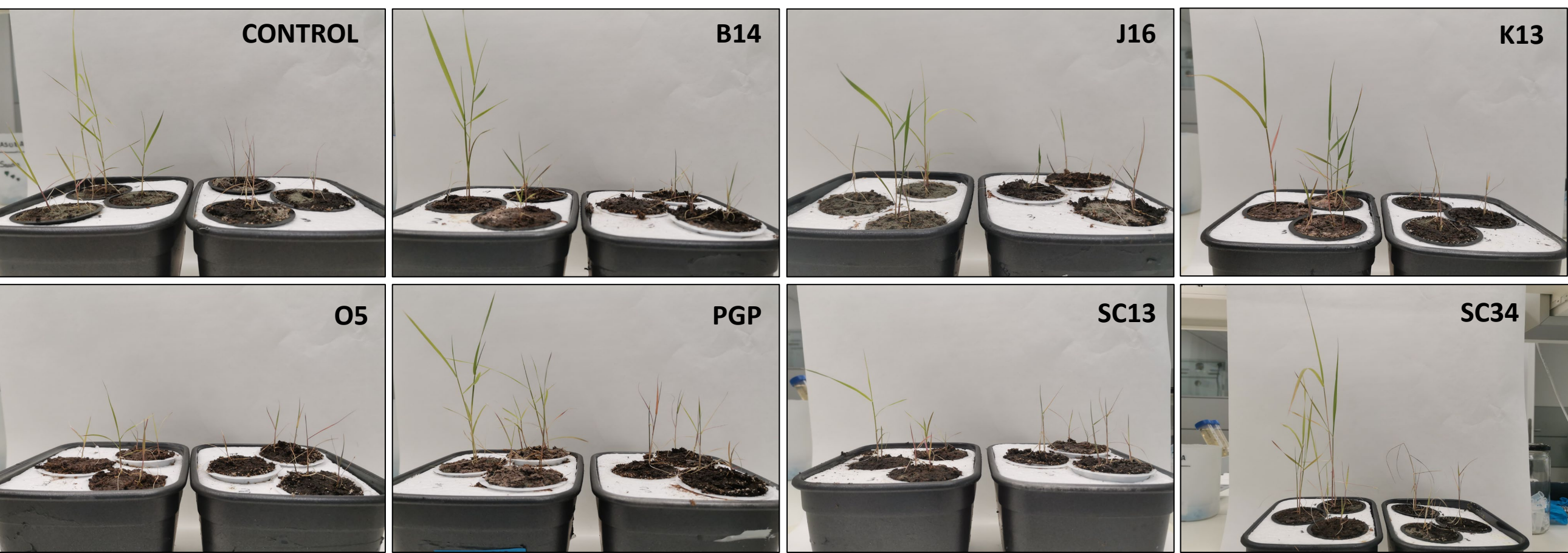


Figure 2. Image showing the condition of plants inoculated with different consortia at the final time point of the experiment.

Consortia	Treatment	Plant Length (mm)		Total Biomass (g)	Pigments (mg/g plant biomass)			
		Root Length	Shoot Length		Chl a	Chl b	Chl Total	Carotenoids
Control	CW	94.82 ± 27.88	74.65 ± 15.17	0.535	0.396	0.134	0.529	0.133
	PW	18.37 ± 2.97	42.81 ± 3.05	0.010	0.263	0.115	0.377	0.113
B14	CW	92.14 ± 47.59	51.70 ± 18.60	0.478	0.317	0.104	0.421	0.099
	PW	22.80 ± 3.71	35.68 ± 3.32	0.114	0.26	0.099	0.359	0.085
J16	CW	79.85 ± 38.18	60.99 ± 14.69	0.512	0.504	0.171	0.675	0.157
	PW	22.27 ± 6.00	42.03 ± 5.95	0.230	0.29	0.106	0.396	0.102
K13	CW	155.02 ± 36.74	72.33 ± 9.26	1.370	0.486	0.175	0.661	0.167
	PW	21.38 ± 5.54	29.56 ± 4.64	0.085	0.157	0.067	0.223	0.093
O5	CW	38.06 ± 18.15	36.22 ± 5.31	0.169	0.338	0.119	0.457	0.131
	PW	13.67 ± 0.52	37.70 ± 3.21	0.149	0.212	0.082	0.295	0.08
PGP	CW	132.91 ± 70.71	65.61 ± 16.42	0.768	0.43	0.145	0.575	0.132
	PW	24.66 ± 2.85	56.47 ± 7.55	0.231	0.322	0.116	0.438	0.108

Table 2. Phenotypic measurements from the experiment by consortium at the microcosm .CW indicates control water treatment , and PW indicates polluted water..

CONCLUSIONS

- Among the **30** bacterial isolates obtained from *P. australis* roots, only **13** exhibited at least one plant growth-promoting trait, indicating their potential as PGPRs.
- Based on phenotypic measurements (plant height, leaf number, and biomass), **soil inoculation** outperformed the root and seed inoculation, making it the most effective delivery method.
- Consortia generated using the iACME aggregation protocol were selected based on growth performance, with **aerobic conditions** yielding superior results; the four resulting aerobic consortia were **K13, B14, O5, and J16**. Among all tested consortia, **J16** demonstrated the most favorable phenotypic outcomes in terms of pigment content, plant height, and total biomass, making it the most promising candidate for upscaling in mesocosm-level phytoremediation experiments.

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BIOSYSMO project has received funding from the European Union's Horizon Europe research and innovation programme. under the grant agreement N° 101060211.



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