# ENDOPHYTIC RHIZOBACTERIA AND COMPANION PLANTING INFLUENCE ON EFFICIENCY OF ASSISTED PHYTOEXTRACTION

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## Introduction

Phytoextraction uses natural or induced capacity of plants to uptake metals in order to remove contamination from soil (Jadia and Fulekar, 2009). However, its efficiency is still not high enough and three main factors limiting phytoextraction rate (biomass production, metal accumulation in plant tissue and metal translocation to aboveground organs) need to be improved before it will be economically viable. Our study was performed to address these issues, by applying endophytic plant growth promoting rhizobacteria (PGPR) and companion planting in assisted phytoextraction.

## Methods

Indian mustard *Brassica juncea* was grown in greenhouse in pots filled with Zn, Pb, Cd contaminated soil collected from Piekary Śląskie (Poland), as a monoculture or with accompanying plant species: alfalfa *Medicago sativa* or maize *Zea mays*. Half of the pots were inoculated with *Burkholderia phytofirmans* PsJN$^T$ (Sessitsch et al., 2005). After 5 weeks plant material was harvested and assessed i.e. in terms of plant survival, plant biomass, root and shoot length; chlorophyll a and b content, reactive oxygen species generation, activity of antioxidative enzymes (spectrophotometrically); and metal accumulation in aboveground tissues (with inductively coupled plasma mass spectrometry, ICP-MS). Total metal yield was calculated as the sum of metal yield (a product of number of harvested plants, average metal content in aboveground tissue and average dry biomass), of plants grown in each variant, e.g. in co-planting of Indian mustard and alfalfa total yield would be the sum of metal yield from *B. juncea* and from *M. sativa* [in mg].

## Results

Inoculation with PGPR and companion planting increased average plant dry biomass, plant survival and, in some cases, bioconcentration factor of *B. juncea* (McGrath and Zhao, 2003). Figure 1 shows the most efficient variants (either with or without PGPR inoculation) of each *B. juncea* culture (monoculture, co-planting with maize or alfalfa), presented as % of control variant 'Bj PGPR –' (*B. juncea* in monoculture without inoculation).

Inoculation with PGPR altered plant response to abiotic stress, as shown by reactive oxygen species generation and activity of enzymes. Even though co-planting decreased the area for growth available for metal accumulating *B. juncea* (in co-planting pots the amount of sown *B. juncea* seeds was two times lower) it increased phytoextraction rate. In the most efficient variant: co-planting of Indian mustard with alfalfa inoculated with PGPR, we achieved an increase in total metal yield: by 95% for Zn, 90% for Cd and approx. 160% for Pb, compared to control plants of Indian mustard grown in monoculture.

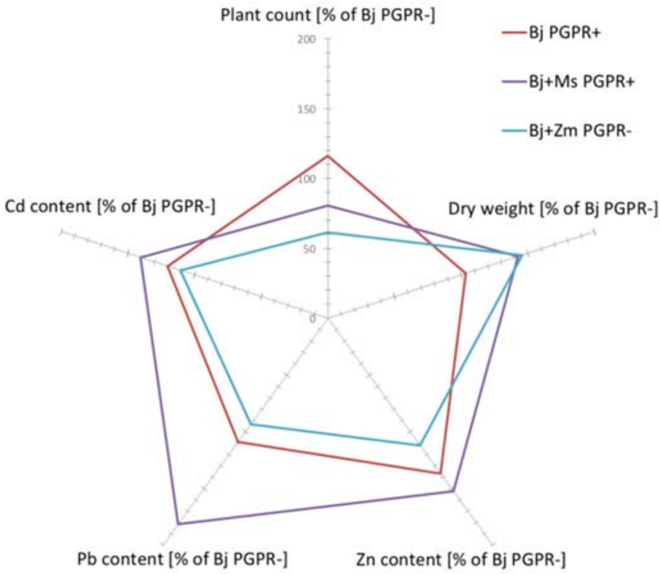


**Figure 1.** Star chart presenting five parameters: plant count; Zn, Pb and Cd content; and dry weight, of most efficient variants of *B. juncea* culture, as % of control variant. Description: Bj – *B. juncea*, Ms – *M. sativa*, Zm – *Z. mays*. 'PGPR– '– no inoculation, 'PGPR+' – inoculation.

## Conclusion

Co-planting and inoculation with rhizobacteria increased efficiency of metal phytoextraction, by increasing the survival rate of plants grown on contaminated soil, increasing the yield of dry biomass and/or increasing the bioconcentration factor of Indian mustard.

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