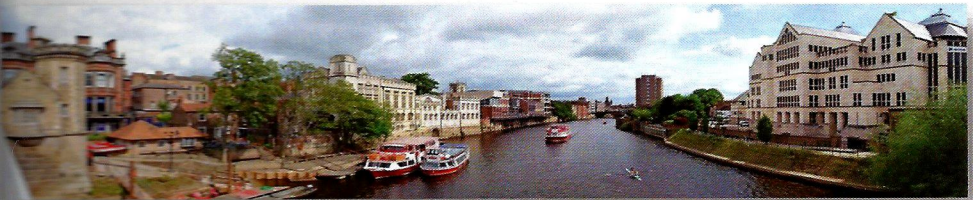


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# Book of Abstracts

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# Bioinocula application in maize plants growing in a P-deficient agricultural soil

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## INTRODUCTION

According to the United Nations predictions, the human population will reach 9 billion people by 2050, being imperative an increase in food supply. Phosphorus (P) is a limiting factor in crop growth and, due to its low availability, P-deficiency in soils is widespread, and as such the successive application of P-fertilizers to maintain crop production has occurred (Sharma et al., 2013), leading to severe environmental problems. Microbial mediated P management appears as an eco-friendly tool for agricultural sustainable practices. The harnessing of Phosphate Solubilizing Bacteria (PSB) seems to be of utmost importance towards the reverse of the current use of large amounts of P fertilizers, since they can stimulate plant growth in particular through the conversion of bound P in soil into bioavailable P forms (Pereira and Castro, 2014).

This work aimed to evaluate the ability of phosphate-solubilizing bacteria (PSB) to enhance *Zea mays* growth in an agricultural P-deficient soil. Strains were screened for their ability to solubilize P and to produce plant growth promoting (PGP) substances. The best P-solubilizing strains *Rhodococcus* sp. EC35 (B1), *Pseudomonas* sp. EAV (B2) and *Arthrobacter nicotinovorans* EAPAA (B3) were inoculated in maize plants growing in P-deficient soils without P fertilization and amended with soluble ( $\text{KH}_2\text{PO}_4$ ) and with tricalcium phosphate (TCP).

## METHODS

The ability of bacterial isolates to solubilize phosphate was performed in liquid culture using National Botanical Research Institute's phosphate growth medium (NBRIP) supplemented with  $5 \text{ g l}^{-1}$  of TCP. Strains were sampled at different time intervals (0, 1, 2, 3, 6, 8 and 10 days) for determining soluble phosphate, pH and acid phosphatase. Bacterial strains, *Rhodococcus* sp. EC35; *Pseudomonas* sp. EAV and *A. nicotinovorans* EAPAA, were used for exploring their potential to improve *Z. mays* growth in P-deficient soils. Greenhouse experiment consisted of a factorial design with three phosphate treatments: control – without P fertilization, soluble P ( $\text{KH}_2\text{PO}_4$ ) and TCP (sparingly soluble P) and 5 types of inoculation: no bacteria – B0 (uninoculated control), B1 (*Rhodococcus* sp. EC35), B2 (*Pseudomonas* sp. EAV), B3 (*A. nicotinovorans* EAPAA) and BM – (mixture of B1, B2 and B3). After 90 days plants root elongation, shoot height and plant dry biomass were determined. Total P in the roots and shoots and available P in rhizosphere soils were determined at the end of experiment. The persistence of inoculated strains in soils was evaluated by Denaturing Gel Gradient Electrophoresis (DGGE).

## RESULTS AND DISCUSSION

The PSB decreased pH of the growth medium and simultaneously increased soluble P when grown in liquid culture. The negative relationship observed suggested that acidification of the medium could facilitate P solubilization.

In soils amended with TCP, the bacterial strain that better performed was *A. nicotinovorans* EAPAA (B3) which increased root biomass by 81% and root P concentration by 8.6%. Mixed inoculation (BM), also promoted root biomass production by 83% and P uptake by 2.6%. These results clearly indicated that inoculation with strains B3 and with BM is closely related to a better absorption of P from soil. Bacterial inoculation also improved *Z. mays* biomass and P root and shoot accumulation in soils without P fertilization, despite the initial low levels of available P in soils. The results obtained by DGGE showed that rhizobacteria were able to colonize rhizosphere soils of the *Z. mays* plants and were detectable after 45 days in all treatments. Taking into consideration that maize need a higher P supply in the initial stages of development, the persistence of bacterial strains in rhizosphere soils at least up to 45 days (half the life cycle of the plant) showed that these PSB can be used as bioinoculants and significantly promote growth of *Z. mays* in P-deficient soils, especially in early stages of maize growth.

## CONCLUSIONS

Inoculation of *Z. mays* plants with selected rhizobacteria significantly enhanced plant growth and nutrition in P-deficient soils. Strains *Rhodococcus* sp. EC34, *Pseudomonas* sp. EAV and

*A. nicotinovorans* EAPAA may be used as biofertilizers in order to improve maize growth in P-deficient soils, constituting an interesting alternative to the application of P fertilizers, reducing costs and improving crop yields.

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## REFERENCES

- Pereira S.I.A., Castro P.M.L. (2014). Phosphate-solubilizing rhizobacteria enhance *Zea mays* growth in agricultural P-deficient soils. *Ecol. Eng.* 73:526-535.
- Sharma S.B., Sayyed R.Z., Trivedi M.H., Gobi T.A. (2013). Phosphate solubilizing microbes: sustainable approach for managing phosphorus deficiency in agricultural soils. *SpringerPlus* 2: 587.