Phosphate solubilizing activity of native Guatemalan isolates of *Pseudomonas fluorescens*

José Alejandro Ruiz-Chután [1, 2], Julio Ernesto Berdúo-Sandoval [2], Aníbal Sacbajá [2], Bohdan Lojka [1], Marie Kalousová [1], Jana Žiarovská [3], Cusimamani Fernández Eloy [1], Amílcar Sánchez-Pérez [2]

Introduction

Phosphorus (P) is an essential element in agricultural production. However, due fixation phenomenon in the soil, especially in Andisol soils of volcanic origin, only a small portion of can be used by plants [1]. Phosphate solubilizing microbes (PSMs) are an alternative to transform this element into soluble forms that can be used by plants; in addition to not generating environmental pollution [2]. In this study we aimed to assess in vitro the phosphate solubilizing activity and stability of native Guatemalan isolates of *Pseudomonas fluorescens* bacteria and its relation with its genetic diversity to find a viable alternative to the dependence on phosphorus fertilizers in the Andisols soils of Guatemala.

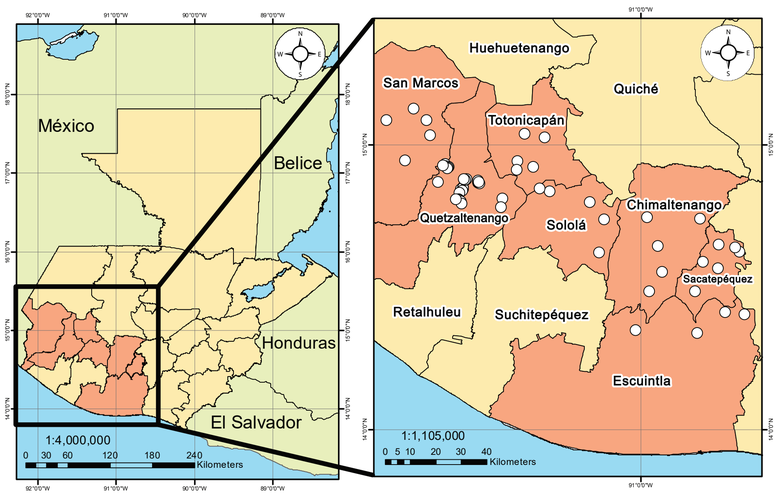

Figure 1. Collecting sites

Methodology

From Andisol soil samples (Figure 1), we obtanined 35 *P. fluorescens* isolates confirmed by PCR, and then we used AFLP molecular marker to evaluate its genetic diversity. The isolates were cultured in NBRIP medium with $Ca_3(PO_4)_2$ as an insoluble source of phosphorus, and the phosphate solubilization index (PSI) was measured (Figure 2). Data analysis: solubilization capacity - ANOVA and Tukey's test (Agricolae [3], genetic diversity (Past [4]).

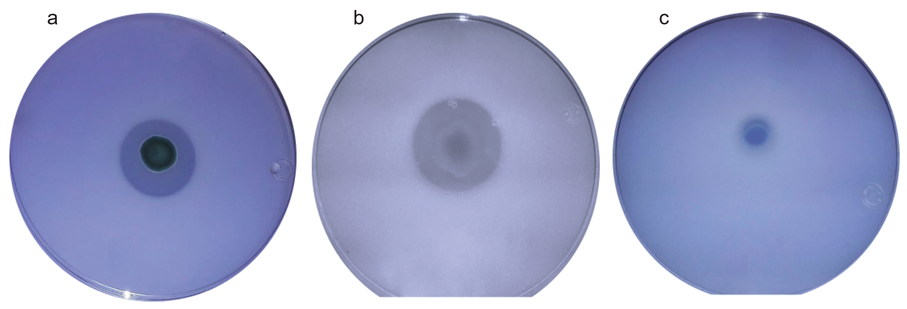

Figure 2. a, b) Isolates with higher PSI; c) Isolates with lower PSI

Results

We found a high genetic diversity within the analyzed isolates forming a first group with highest and a second group with lowest PSI, Respectively (Figure 3). The ANOVA analysis showed significant differences ($p<.01$) of the PSI between isolates and also between collecting sites (Figure 4). At isolates level (Tukey's test groups $p < .01$), the Pf_33, collected in Sacatepéquez, showed the highest PSI whereas Pf_29, collected in Totonicapán, showed the lowest value. At collecting sites level, Sacatepéquez showed the higher and Totonicapán the lower PSI, respectively. About solubilization stability, we did not observe a defined pattern (Figure 5).

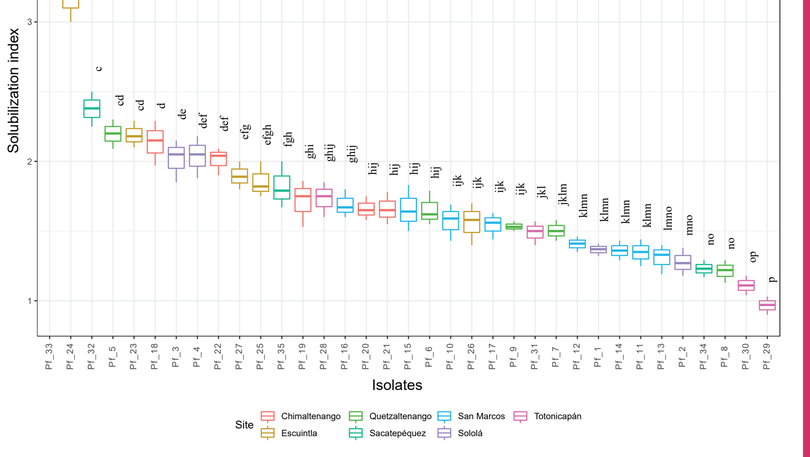

Figure 3. *Neighbor-Joining* dendrogram of 35 *P. fluorescens* isolates showing the genetic diversity and linkage with the solubilizing capacity

Figure 4. Phosphate solubilization index of all *P. fluorescens* isolates

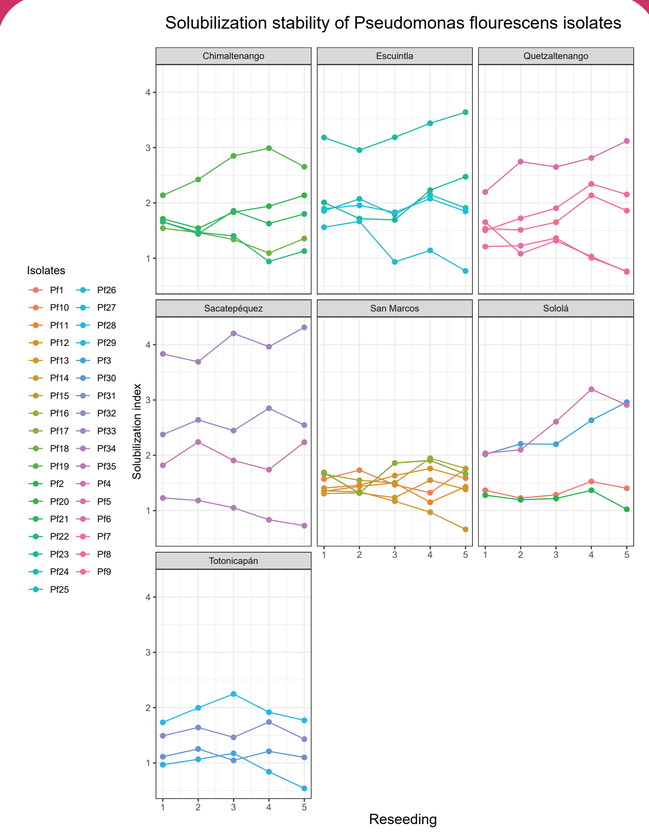

Figure 5. Solubilization stability of all *P. fluorescens* isolates

Conclusions

Here we show that native isolates of *P. fluorescens* have the potential to be a sustainable alternative to the problem of phosphorus fixation, from which the current dependence on chemical fertilization results. It is also important to mention the advantage of local adaptation of native isolates to biotic and abiotic factors. We recommend future research to evaluate the efficiency of isolates under field conditions.

References

[1] Islam, M. K., Sano, A., Majumder, M. S. I., Hossan, M. A., & Sakagami, J. I. (2019). Isolation and molecular characterization of phosphate solubilizing filamentous fungi from subtropical soils in Okinawa. *Applied Ecology and Environmental Research, 17*(4), 9621-9650. doi:10.15666/aeer/1704

[2] Chawngthu, L., Hnamte, R., & Lalfakzuala, R. (2020). Isolation and characterization of rhizospheric phosphate solubilizing bacteria from wetland paddy field of Mizoram, India. *Geomicrobiology Journal, 37*(4), 366-375.

[3] Felipe de Mendiburu (2020). Agricolae: Statistical Procedures for Agricultural Research. R package version 1.3-3. https://CRAN.R-project.org/package=agricolae

[4] Ryan, P. D., Hammer, Ø., & Harper, D. A. (2001). Past: Paleontological statistics software package for education and data analysis. *Paleontologia Electronica, 4*(1), 5-7. https://doi.org/10.1016/j.bcp.2008.05.025

Acknowledgments

The study was supported by Dirección General de Investigación (Digi) through project no. 4.8.63.4.45

1 Czech University of Life Sciences Prague Faculty of Tropical AgriSciences

2 Dirección General de Investigación Universidad de San Carlos de Guatemala

3 Faculty of Agrobiology and Food Resources SUA Nitra