IMPOCHA Project

Evaluation of the Impact of Fungicide Application on Microbial Populations in Potato Crop.

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Introduction

In Belgium, potatoes represent an important crop both economically and agronomically point of view. In 2021, the potato crop covered 80.000 hectares, producing more than 7 million tonnes (Statbel, 2022). However, potatoes are susceptible to fungal diseases, especially potato late blight (P. infestans), which requires control through the use of fungicides during the cropping season. This could influence soil microbial populations.

The international project IMPOCHA (IMPROVING SOIL, POTATO CROPS, HUMAN HEALTH AND FORAGE QUALITY IN A CLIMATE CHANGE CONTEXT) focuses on studying the impact of agricultural practices, particularly fungicide applications, on soil microbiome biodiversity in potato crops. This project is funded by BELSPO (Belgian Science Policy Office) and brings together researchers from China, South Africa and Belgium over a three-year period (July 2021 – June 2024). The biotechnology and applied biology laboratory conduct the study of bacterial and fungal populations through targeted sequencing (Illumina MiSeq System) from 18 soil (9 farmers, including 3 organic and 6 IPM) in Wallonia. The primary research questions are: (I) Is there an effect of fungicide applications on soil microbial populations? (II) Do cultural methods (organic and IPM) affect soil microbiota?

Methods

Sampling was conducted over the years 2022 and 2023 in 18 potato plots from planting to harvest and following fungicide spaying. DNA extraction was carried out after sieving fresh soil samples. The sequencing step involved targeted sequencing of the 16S rDNA genus of bacteria (V3-V4 region) and ITS2 region of fungi using a V3 600 cycles cartridge in our MiSeq System. Bioinfornatics processing was performed using DADA2 software in a Custom-built pipeline.

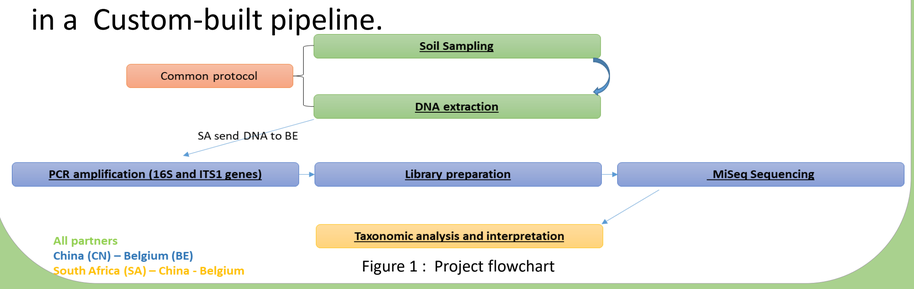

Figure 1 : Project flowchart

Results and discussion

After taxonomic assignment, the microbial diversity of all samples was converted to relative abundance for chart visualization and statistical analysis. Initially, we performed a PCoA (Principal Coordinates Analysis) analysis for all samples to explore the clustering of samples based on microbial composition. Simultaneously, a PERMANOVA test was conducted with the variables "cultural method" (IPM or Organic) and "time (date)". Subsequently, the Shannon diversity index was analyzed, focusing particularly on comparisons between organic and IPM farmers using the Wilcoxon test.

The PCoA analysis and PERMANOVA test revealed significant clustering for fungi based on cultural method (Figure 3), which is corroborated by a higher Shannon index for organic farmers (Figure 4). Conversely, no significant effects were observed for bacterial populations.

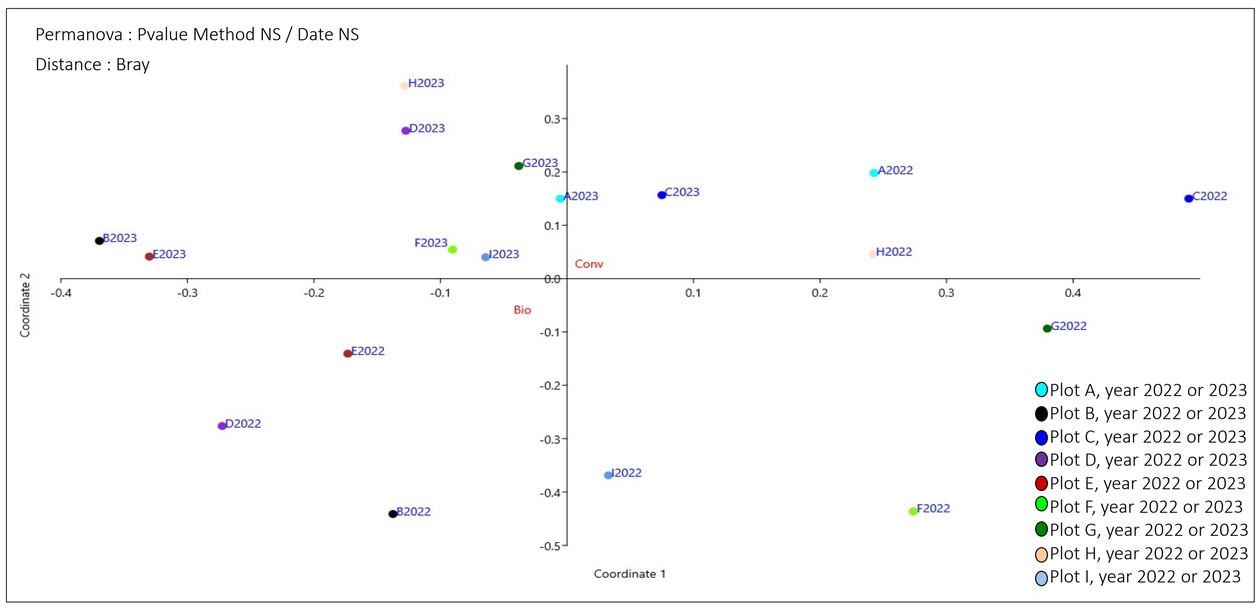

Figure 2 : PCoA for bacterial genera, years 2022 – 2023

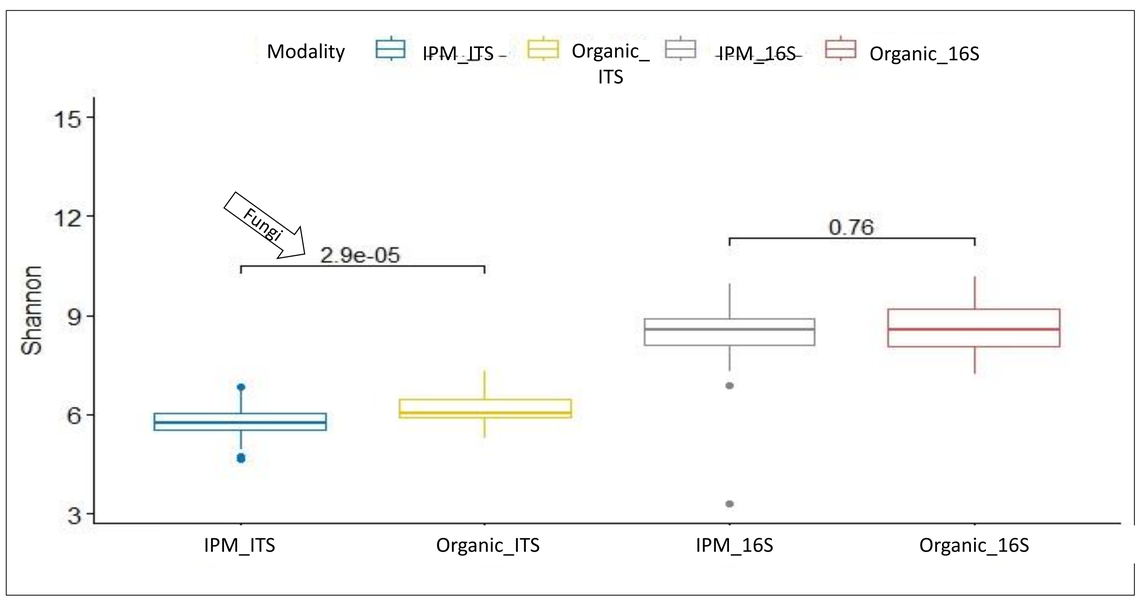

Figure 4 : BoxPlot of Shannon index for bacterial and fungal populations : comparison of organic and IMP plots for cropping season 2022 and 2023.

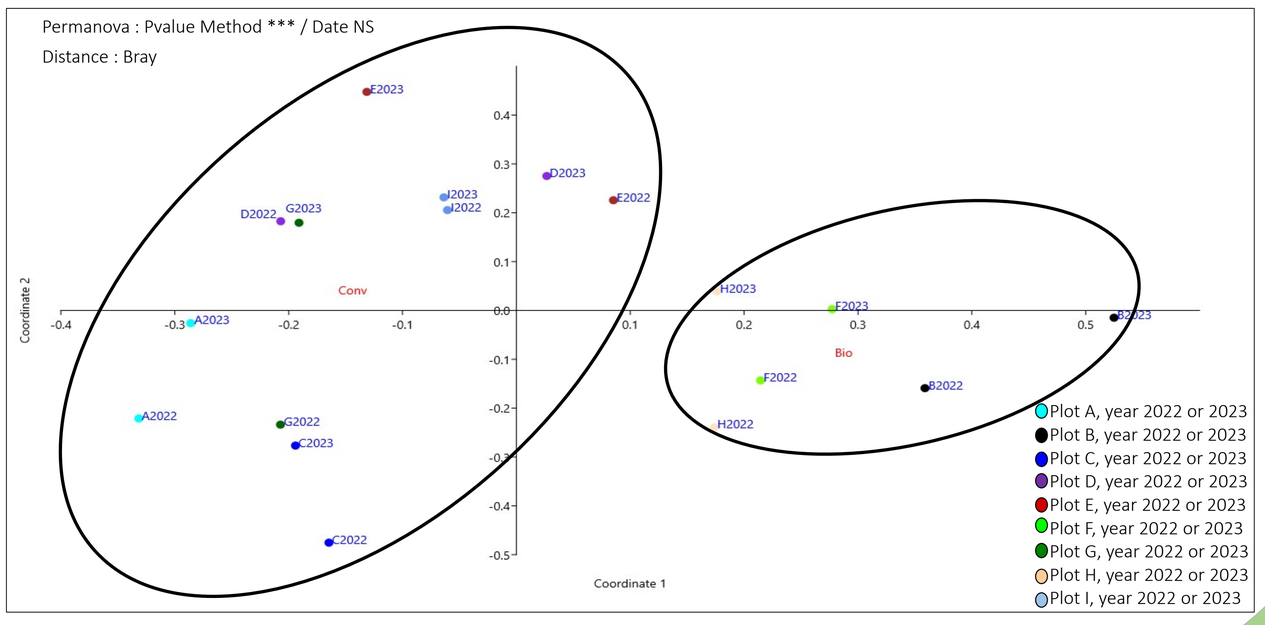

Figure 3 : PCoA for fungal genera, years 2022 – 2023

Conclusion and Perspective

The samples taken during the 2022 and 2023 growing season made it possible to analyze the dynamics of bacterial and fungal populations over time and on different plots (organic and IPM farmers) spread across the territory of the province of Hainaut. Several observations can be made following the analyzes carried out:

- The microbial populations seem stable over time and only a few differences are noticeable for the poorly represented genera, which means no significant effect regarding fungicide application for cropping season 2022 and 2023.
- A significant effect is observed regarding cropping method for fungal populations and Shannon index with higher value in organic crop for fungi.

Currently the functional data and the comparative analysis (between country) was not used but this is a goal that is in progress. To illustrate this, the box plot next to it (figure 5) show the plant pathogen abundance between organic and IPM plots for samples of 2022. Other functions can be analyzed to refine the results.

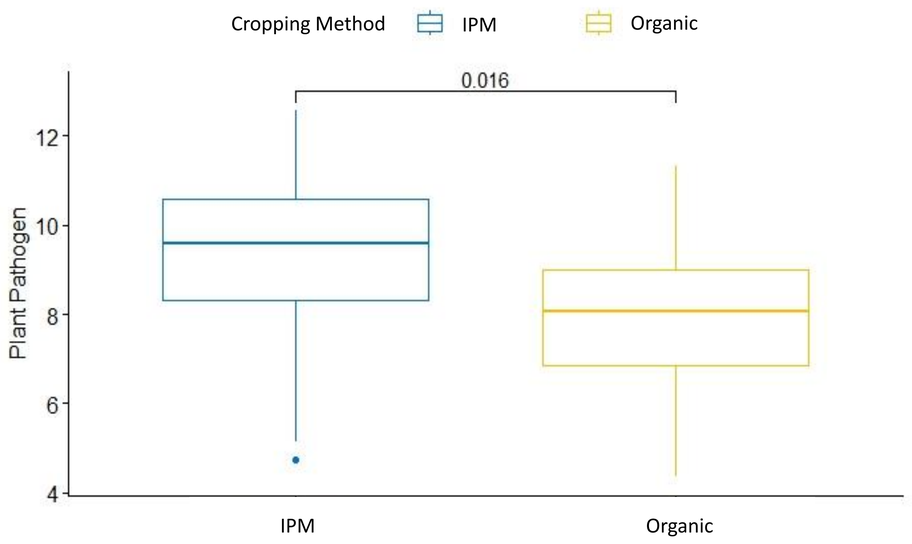

Figure 5 : Box Plot of Plant Pathogen: Comparison of Organic and IMP plots for the year 2022.