

Application of a PGP Bacterial Bioinoculant in a Vineyard: Impact on Soil Biochemical Properties and Must Composition



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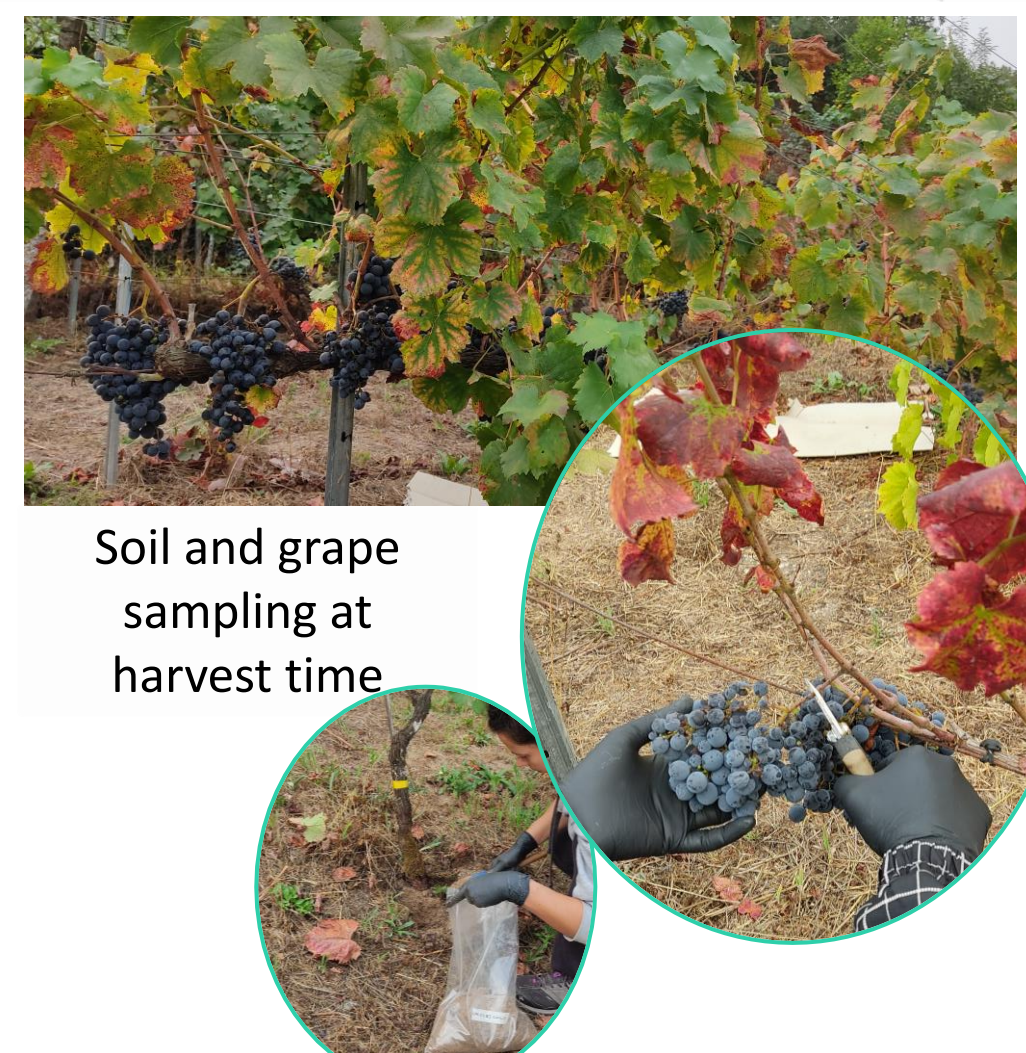
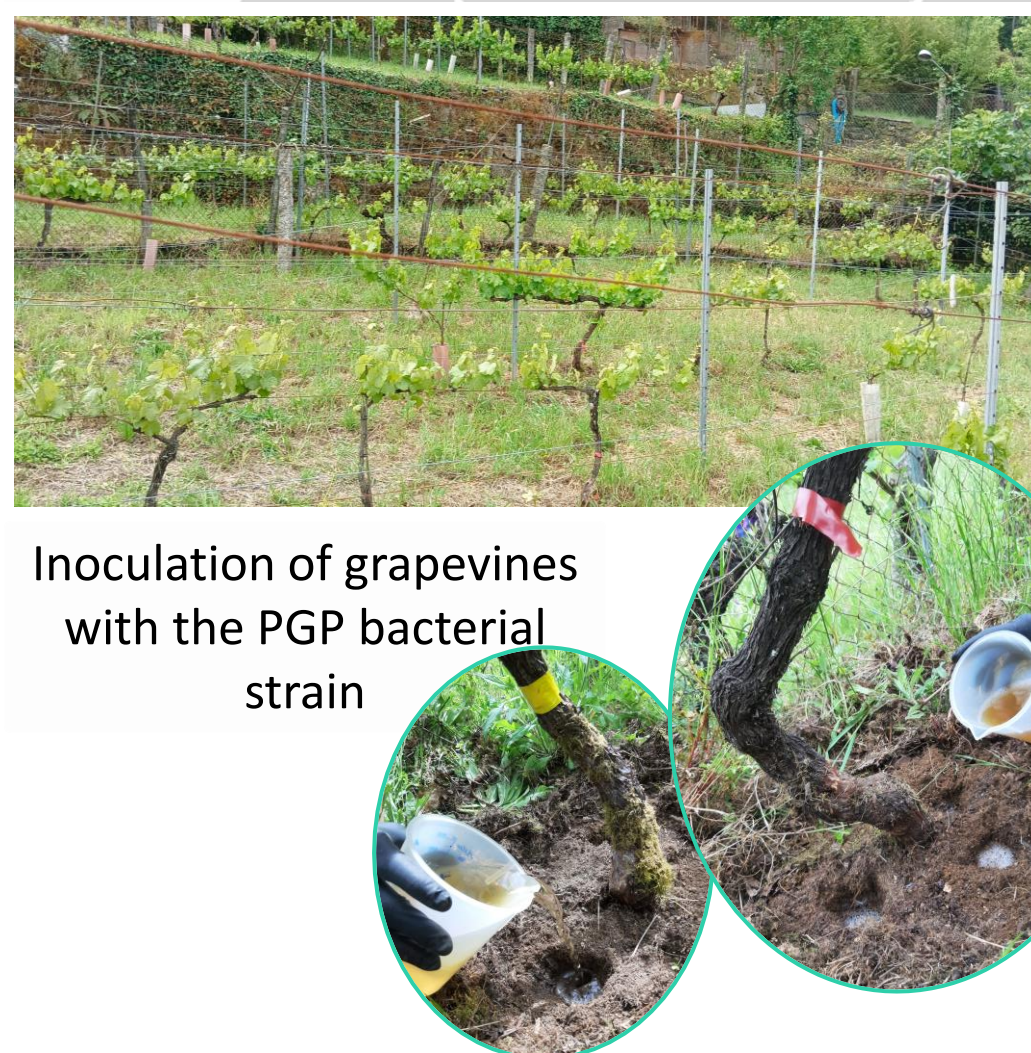
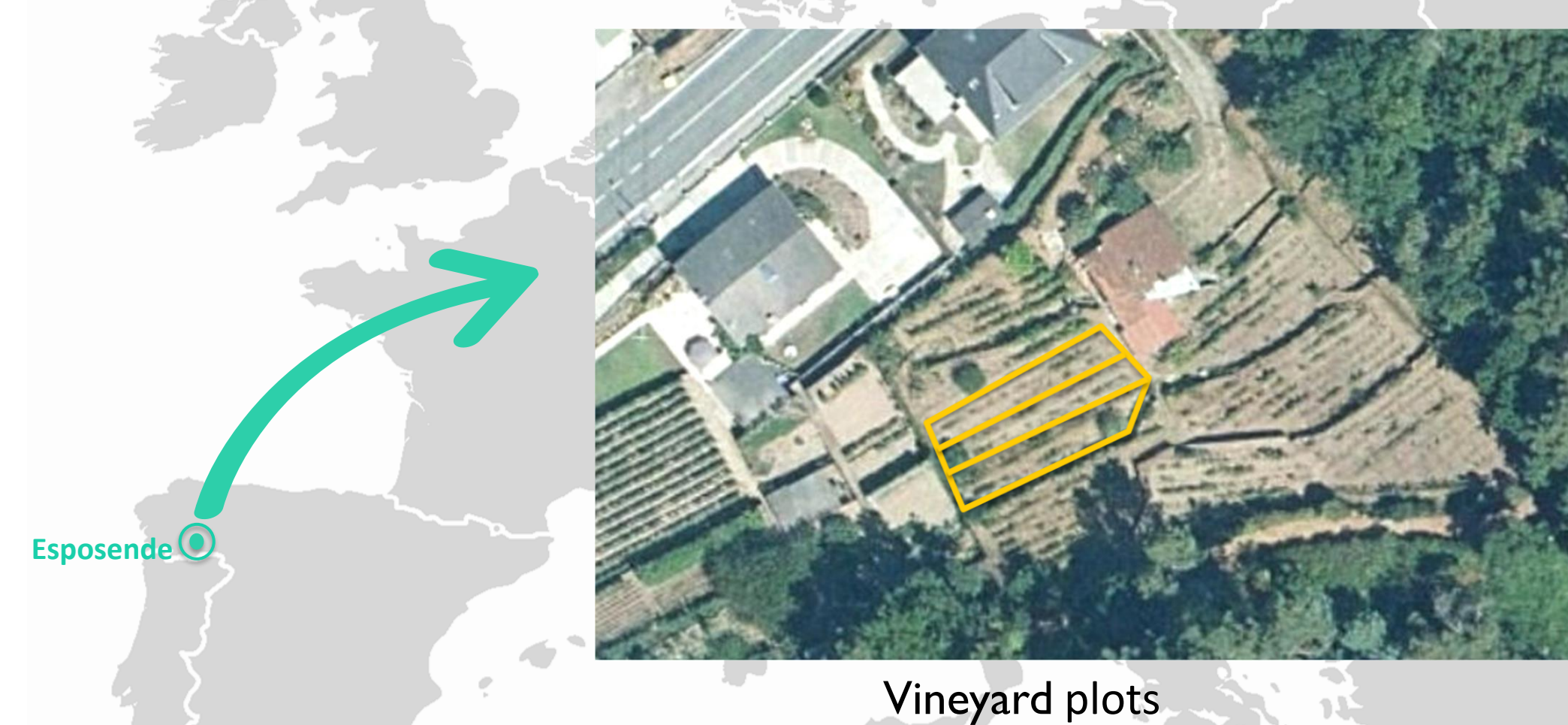
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Introduction

Sustainable agriculture increasingly relies on the use of environmentally friendly practices and biotechnological tools to maintain soil health and productivity. The ReCROP project, funded by the PRIMA-Med programme, aims to enhance soil functions and resilience through integrated cropping systems. As part of this initiative, we evaluated the effects of a plant growth-promoting (PGP) bacterial bioinoculant applied in a vineyard of the Mencia grape variety located in the Ribeiro Denomination of Origin (Galicia, NW Spain). This study explores the bioinoculant's influence on soil biochemical properties and must composition over two growing seasons.

Experimental field site

The field trial was conducted in a vineyard located in the Denomination of Origin (D.O.) Ribeiro area, specifically in A Gandarela – Esposende, within the municipality of Ribadavia (Galicia, NW Spain). The vineyard is situated at GPS coordinates 42.2959, -8.1327 and is registered in the SIGPAC system under code 32 70 00 44 148. The site is representative of typical Ribeiro vineyards, characterized by a temperate Atlantic climate. The experimental area covered approximately 0.03 ha and consisted of three plots, each with an approximate area of 100 m².



Material and Methods

The study was conducted over two consecutive cropping seasons (2023 and 2024) in the described experimental vineyard.

A plant growth-promoting (PGP) bacterial strain, *Arthrobacter nicotinovorans* EAPAA, was used as a bioinoculant. The selected PGP strain presents beneficial traits such as phosphorus solubilization and nitrogen fixation. The strain was cultured in Tryptic Soy Broth (TSB) and the inoculum consisted of 500 mL of a bacterial suspension with an optical density of 1.0, applied at the base of each grapevine stock in early spring. In each plot, four grapevines were inoculated and four were treated with 1/3 diluted TSB as controls.

At harvest, soil and grape samples were collected from both non-inoculated and inoculated vines. Soil samples were taken at the base of each vine and pooled to obtain one composite sample for the inoculated and one for the non-inoculated treatments per plot.

Soil analyses:

- General soil characterization: pH, texture, organic matter, total N, labile P, exchangeable cations.
- Labile carbon compounds: hot water-soluble total organic C, carbohydrates and polyphenols.
- C and N mineralization.
- Enzymatic activities: dehydrogenase, catalase, CM-cellulase β -glucosidase, invertase, casein-protease, urease, phosphodiesterase, acid phosphomonoesterase, and arylsulphatase.

Must analyses

- pH
- Sugar content (Brix)
- Organic acid profile (HPLC)

Results

The PGP bioinoculation led to improvements in several key soil properties. Inoculated soils exhibited increased N mineralization (Figure 1). A significant rise—up to 65%—in labile P (Figure 2) and labile C compounds (Figure 3) was also observed in treated plots. Additionally, enzymatic activities were generally enhanced by the bioinoculant application, particularly the activity of enzymes involved in the N (casein-protease, urease) and P cycles (acid phosphomonoesterase) (Figure 4).

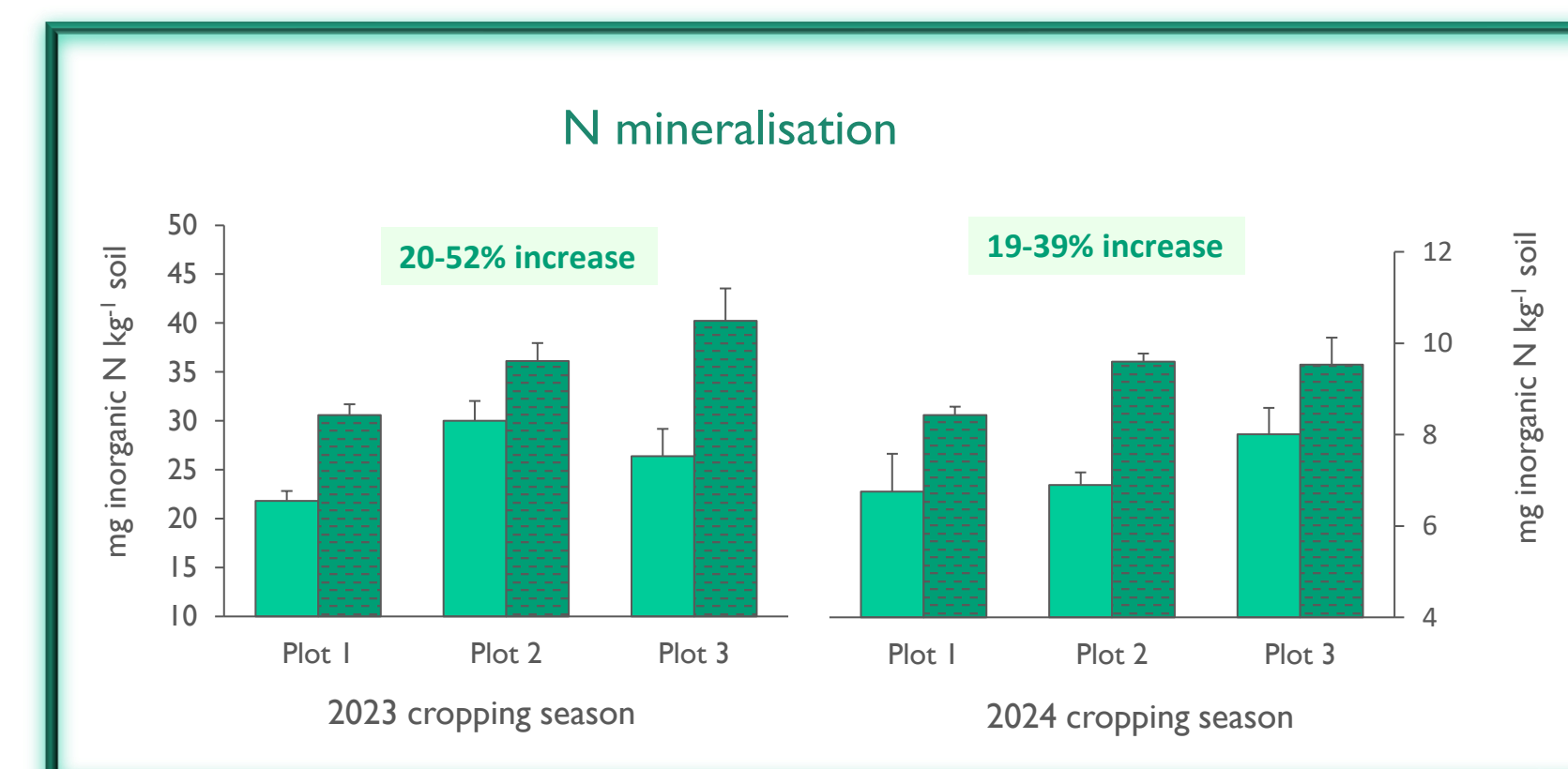


Figure 1. Nitrogen mineralization in inoculated (■) and non-inoculated (■) soils after three weeks of incubation.

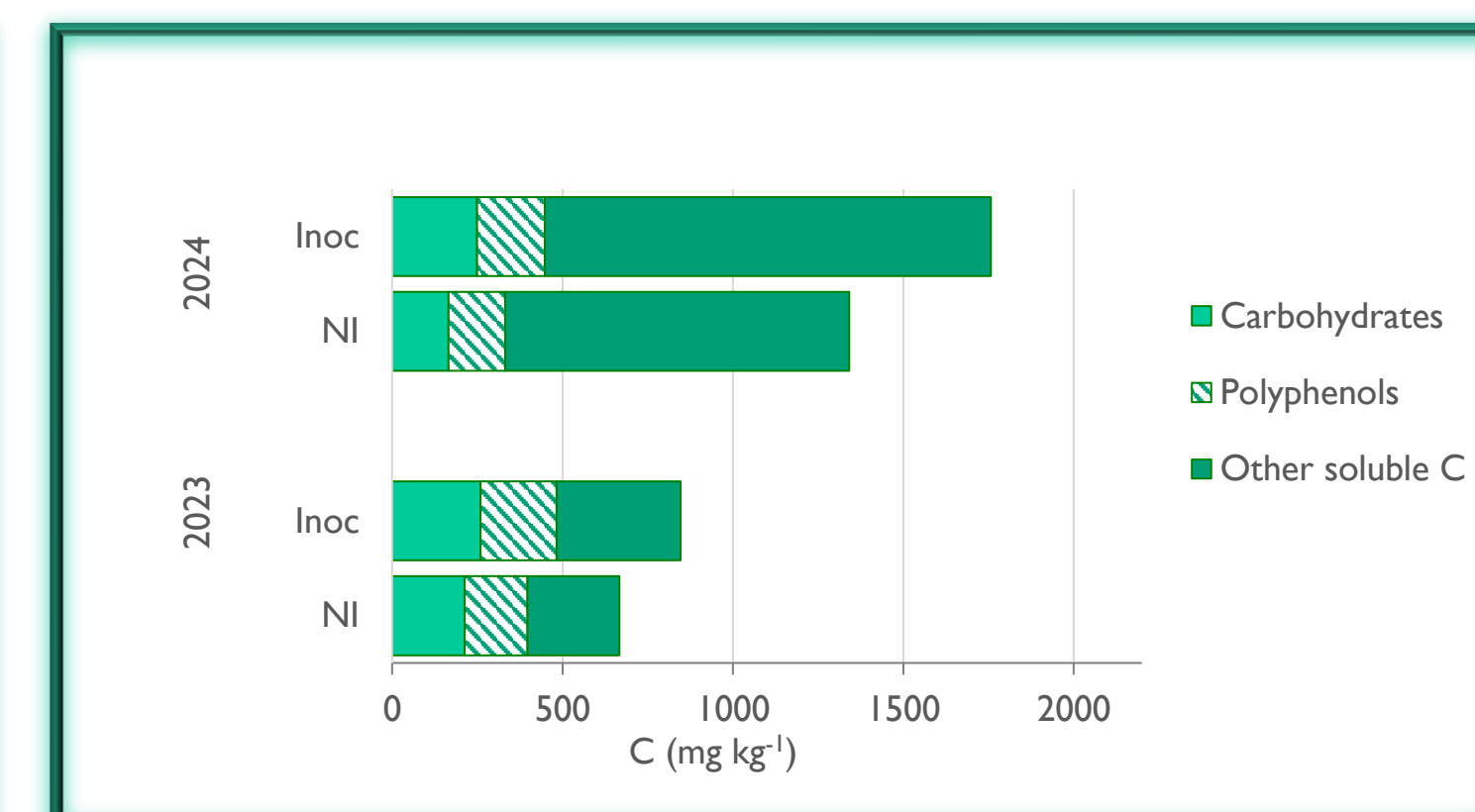


Figure 3. Hot water extractable C compounds.

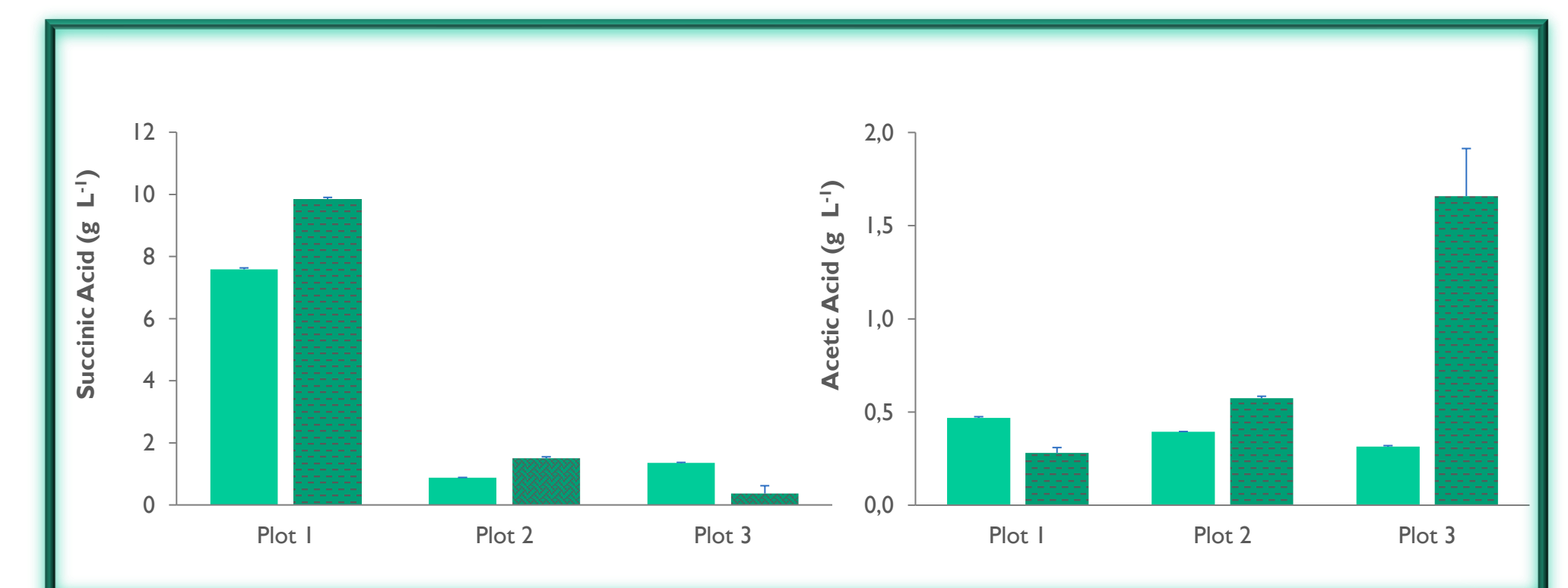


Figure 5. Succinic and acetic acid concentrations in must samples from the 2024 harvest obtained from non-inoculated (■) and inoculated (■) grapevines.

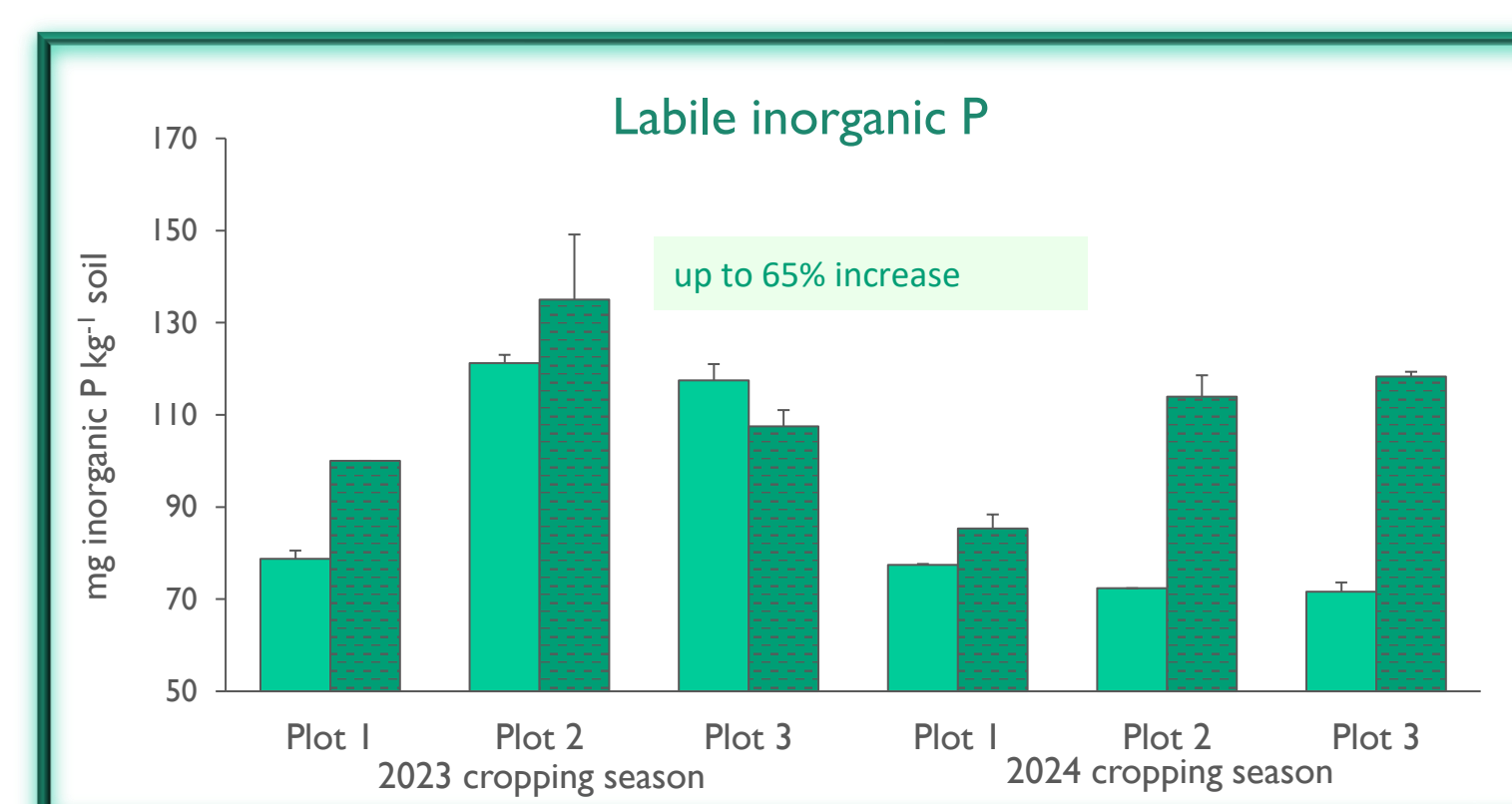


Figure 2. Labile P in inoculated (■) and non-inoculated (■) soils.

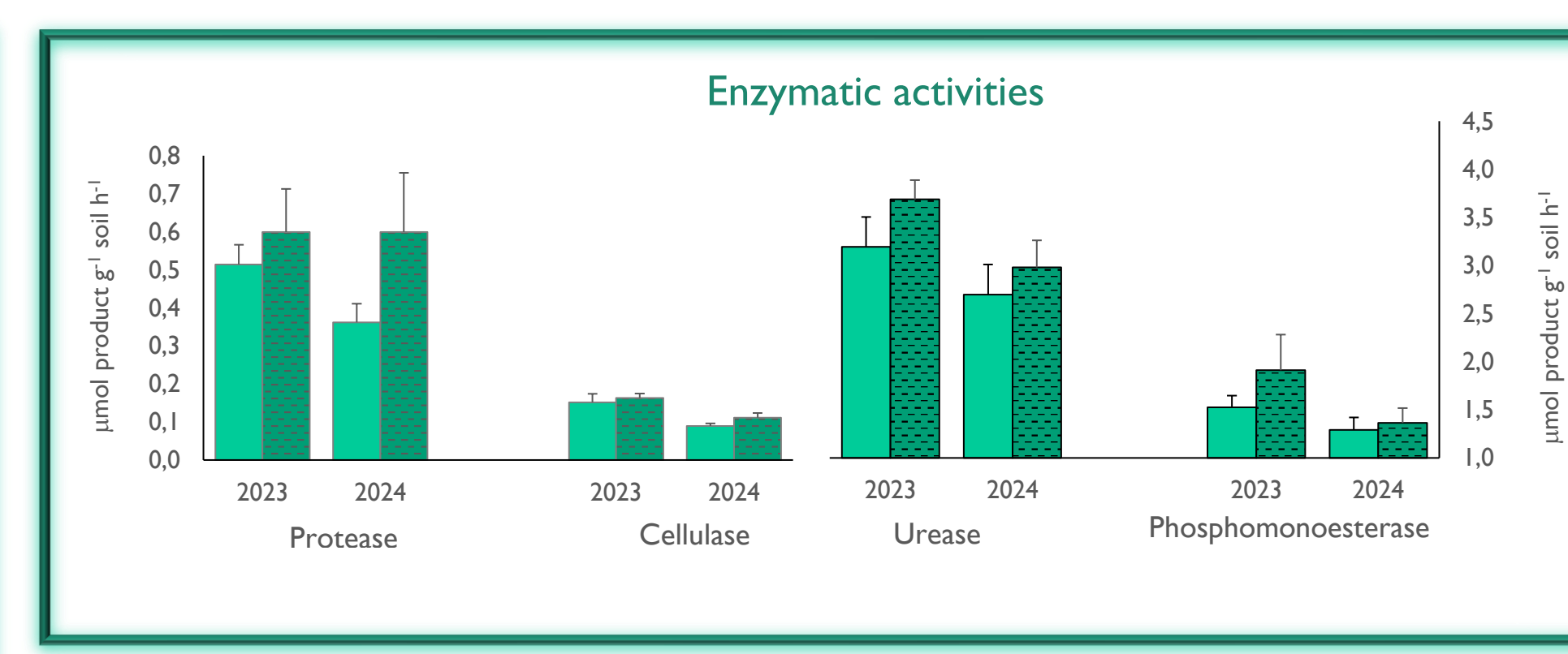


Figure 4. Casein-protease, cellulase, urease and acid phosphomonoesterase activities in inoculated (■) and non-inoculated (■) soils.

Conclusions

The bioinoculation with the PGP strain *Arthrobacter nicotinovorans* EAPAA in a Mencia vineyard led to several soil beneficial effects:

- ✓ Improved availability of labile C and labile P
- ✓ Enhanced soil biological and biochemical activity, particularly of the N and P cycles

The bioinoculation also appears to induce modifications of must composition, which should be further studied to analyse their impact in the vinification process.

These findings suggest that the bioinoculant can contribute to improving soil functionality and may influence grape quality, offering a promising strategy for sustainable vineyard management.

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Bioinocula and CROPping systems: an integrated biotechnological approach for improving crop yield, biodiversity and Resilience of Mediterranean agro-ecosystems.

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