SILICON INDUCES THE BIOSYNTHESIS OF LIGNIN IN WHEAT CULTIVARS GROWN UNDER PHOSPHORUS STRESS

SOFÍA PONTIGO[1,2], ISIS VEGA[1], PAULA CARTES[1,2]

[1]Center of Plant, Soil Interaction and Natural Resources Biotechnology, Scientific and Technological Bioresource Nucleus (BIOREN-UFRO);
[2]Departamento de Ciencias Químicas y Recursos Naturales, Facultad de Ingeniería y Ciencias Universidad de La Frontera, Temuco, Chile.
*corresponding author e-mail: paula.cartes@ufrontera.cl
ARTICLE ID SCIFORUM-043896

Introduction

Although both silicon (Si) and lignin accumulate on cell walls of plants and confer resistance to multiple biotic and abiotic stresses (Bhardwaj et al. 2014; Vega et al. 2020), the impact of Si on lignin production in plants grown under phosphorus (P) deficiency still remains unknown. We evaluated the effect of Si supply on both the lignin accumulation pattern and the expression of lignin biosynthesis-related genes in wheat plants grown at different P levels.

Material and Methods

Two wheat cultivars differing in tolerance to P deficiency (Púrpura-sensitive and Fritz-tolerant) were hydroponically grown with P (0, 0.01 or 0.1 mM) in combination with Si (0 or 2 mM) during 21 days. At harvest, lignin concentration, lignin distribution pattern and the gene expression of phenylalanine ammonia lyase (*TaPAL*) and cinnamyl alcohol dehydrogenase (*TaCAD*) were analyzed in shoots.

Results and Discusion

Lignin concentration of both wheat cultivars did not vary at different P doses; nevertheless, 2 mM Si increased lignin accumulation at either 0 mM P (cv. Púrpura) or 0.01 mM P (cv. Fritz), with a more noticeable effect in Púrpura than in Fritz (Figure 1).

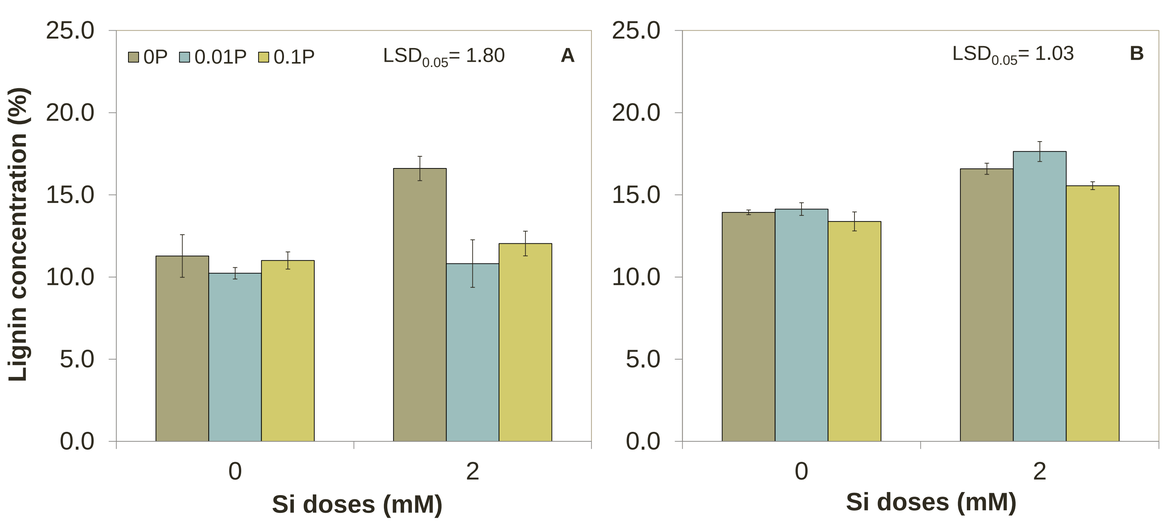

Figure 1. Lignin concentration in shoots of wheat cultivars Purpura (A) and Fritz (B) hydroponically grown with different P and Si doses during 21 days. Data are means of three replicates ± standard deviation. Differences among means were identified using LSD test at the 0.05 significance level.

Similarly, confocal microscopy analyses showed stronger Safranine O staining after Si was added to both cultivars grown under P-limitation (Figure 2).

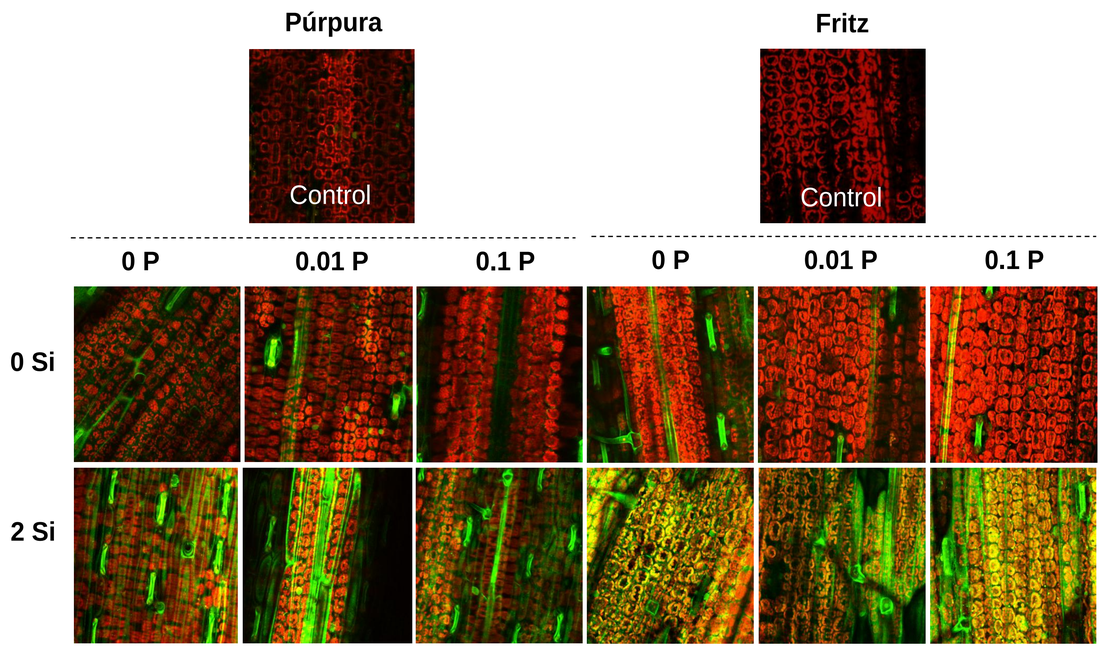

Figure 2. Representative confocal images of lignin accumulation pattern in shoots of wheat cultivars subjected to different P and Si doses. Lignin fluorescence (green) was collected by excitation/emission wave lengths 543 nm/590 nm by Confocal Laser Scanning Microscope.

Interestingly, Si also induced the expression of lignin biosynthesis-related genes (Figure 3). Up-regulation of *TaPAL* was detected in cv. Púrpura grown at low P levels, with a further increase in plants treated with Si (Figure 3A). Likewise, Si addition to P-stressed plants of cv. Fritz increased the transcript level of *TaPAL* by about 1.5-fold (Figure 3B).

Figure 3. Gene expression analysis of *TaPAL and TaCAD* by qRT-PCR in shoots of wheat cultivars Purpura (A-C) and Fritz (B-D) hydroponically grown with different P and Si doses during 21 days. The expression levels were normalized in relation to *Actin* or *eEF1A* gene expression. Data are means of three replicates ± standard error. Differences among means were identified using LSD test at the 0.05 significance level.

Moreover, the expression level of *TaCAD* augmented by about 1.7- fold as a result of Si supply to both cultivars grown in the absence of P (Figure 3C-D).

Conclusion

Overall our results shows that Si induced the biosynthesis of lignin in shoots of wheat plants grown under P stress.

References

Bhardwaj R. et al. (2014) Lignins and Abiotic Stress: An Overview. In: Ahmad P., Wani M. (eds) Physiological Mechanisms and Adaptation Strategies in Plants Under Changing Environment. Springer, New York, NY.
Vega et al. (2020) Silicon Modulates the Production and Composition of Phenols in Barley under Aluminum Stress. Agronomy 10(8), 1138.

Acknowledgments. FONDECYT Regular Project N° 1201257 and FONDECYT Postdoctoral Project N° 3200901.