DOTTORATO DI RICERCA IN BIOLOGIA CELLULARE E DELLO SVILUPPO
42th CYCLE
Main research line
Project proposal for a Sapienza PhD scholarship

Title: Decoding Cell Wall-Derived Redox Signals: Integrating OGOX Activity with OG-Mediated Regulation of Plant Responses

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Summary

Plant cells detect cell-wall damage via cell wall–derived damage-associated molecular patterns (CW-DAMPs), triggering local and systemic immune responses. Oligogalacturonides (OGs), pectin fragments released during wall degradation, are potent CW-DAMPs that rapidly stimulate apoplastic reactive oxygen species (ROS) accumulation and defense responses in *Arabidopsis thaliana*. A central source of OG-induced apoplastic ROS is the NADPH oxidase RBOHD, which integrates Ca^{2+}-dependent and phosphorylation signals to amplify defense signaling and promote long-distance communication. In parallel, OG oxidases (OGOXs; BBE-like enzymes) oxidize OGs in the apoplast, attenuating OG elicitor activity while producing H_2O_2 and reshaping extracellular redox conditions. Extracellular H_2O_2 is sensed by the receptor kinase HPCA1, which can initiate cytosolic Ca^{2+} influx and propagating ROS/Ca^{2+} waves. Despite these advances, it remains unclear how OGOX- versus RBOHD-derived H_2O_2 are integrated, and which downstream redox-sensitive proteins connect extracellular oxidation to defense outputs.
Hypothesis: OGOX activity tunes OG-triggered immunity by modulating apoplastic redox dynamics that gate HPCA1-dependent Ca^{2+} signaling and RBOHD amplification, thereby shaping both cell-autonomous and tissue-level defense propagation.
To test this, (i) the kinetics and spatial spread of OG-induced apoplastic redox changes and cytosolic H_2O_2/Ca^{2+} signals will be quantified, using genetically encoded biosensors (roGFP2-Orp1, HyPer7, GCaMP6f); (ii) source contributions and feedback will be dissected using *ogox* and *rbohD* mutant backgrounds; and (iii) extracellular redox-sensitive protein targets will be identified via apoplastic proteomics for functional validation. Key readouts will include the amplitude and velocity of ROS/Ca^{2+} waves, compartment-specific redox/H_2O_2 kinetics, expression of OG-responsive defense markers, and downstream effects on pathogen resistance. We expect to elucidate how extracellular oxidation regulates ROS/Ca^{2+} waves and identify redox-regulated nodes that control defense activation locally and systemically, advancing mechanistic understanding of plant immunity.

Pertinent Publications of the proponent (last 5 years)

- Salvati, A., Diomaiuti, A., Locci, F., Gravino, M., Gramegna, G., Ilyas, M., ….*Pontiggia D.* § & De Lorenzo, G§. (2025). Berberine bridge enzyme-like oxidases orchestrate homeostasis and signaling of oligogalacturonides in defense and upon mechanical damage. Doi: 10.1111/tpj.70150 ***The Plant Journal,*** *122*(1), e70150 **(§, corresponding author)**.

- Degli Esposti C., Guerrisi L., Peruzzi G., Giulietti S. § and *Pontiggia D.* § (2025). Cell Wall Bricks of Defence: the case study of oligogalacturonides. **Frontiers In Plant Science**, *16*, 1552926. Doi: 10.3389/fpls.2025.1552926 **(§, corresponding author).**

- Gravino, M., Mugford, S.T., *Pontiggia, D.*, Joyce J., Drurey C., Prince D., Cervone F., De Lorenzo, G., Hogenhout, S.A. (2025) Aphid effector Mp10 balances immune suppression and defence activation through EDS1-dependent modulation of plant DAMP responses. **New Phytologist** Doi 10.1111/nph.70419

- Bigini, V., Sillo, F., Giulietti, S., *Pontiggia D.*, Giovannini, L., et al. (2024) Oligogalacturonide Application Increases Resistance to Fusarium Head Blight in Durum Wheat. **J Exp Bot.** doi:10.1093/jxb/erae050.

- Costantini, S., Benedetti, M., *Pontiggia D.*, Giovannoni, M., Cervone, F., Mattei, B., & De Lorenzo, G. (2024). Berberine bridge enzyme–like oxidases of cellodextrins and mixed-linked β-glucans control seed coat formation. **Plant Physiology,** 194(1), 296-313. DOI: 10.1093/plphys/kiad457