DOTTORATO DI RICERCA IN BIOLOGIA CELLULARE E DELLO SVILUPPO

38 CYCLE

Project proposal for a Sapienza PhD scholarship

PNRR CN2 Agritech - spoke 7

Title: Bio-based conversion of agricultural waste biomasses into products for sustainable crop protection

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Summary

Plant diseases cause substantial crop losses worldwide and compromise food safety because of the presence of toxins associated to fungal contamination. Chemical control of pathogens can have negative repercussions on the environment as well as human and animal health, whereas genetic resistance is not durable, as pathogens rapidly evolve to evade it. Huge amounts of organic waste are generated by agriculture and the food industries. These materials represent a potential reservoir of bioactive products, including oligosaccharide elicitors (OEs) capable of activating the natural defense responses of plants against pathogens. The project aims to develop a sustainable strategy to control crop diseases using OEs derived from lignocellulosic biomass from aromatic plants and to investigate the biological mechanisms regulating OE-induced resistance in plants. In particular, after extraction of metabolites of interest, residual plant biomass will be subjected to either chemical-physical treatments or a "bio-based" pre-treatment with ligninolytic fungi to partially degrade cell walls, generating oligosaccharides and increasing their extractability. Pre-treated biomasses will be then subjected to fractionation using low-impact approaches. The fractions will be initially tested in vitro for their ability to induce defense responses and protect against microbial infections in the model plant Arabidopsis thaliana, and biochemically characterized for the presence of known OEs derived both from the biomass itself (oligogalacturonides, cellodextrins) and from the fungus (chitooligosaccharides). The most active fractions will be tested on crop plants (tomato, Brassicaceae species) and their effects, in terms of growth, productivity and resistance to biotic stress, will be determined. To gain insights in the molecular basis of OE-induced resistance, genes differentially regulated during fungal infection in Arabidopsis plants pre-treated with water or OE will be identified and their role in basal immunity and in the regulation of elicitor-induced resistance will be evaluated by reverse genetics. Changes in the levels of hormones and defense-related compounds in WT and mutant plants after elicitation, both in the absence and in the presence of pathogens, will be determined to correlate them with induced resistance. In addition, the impact of elicitors, beneficial microorganisms and their combination on aromatic plant metabolite accumulation and cell wall composition will be investigated. The obtained results will allow the valorisation of

plant biomasses generated by the agri-food sector, developing a sustainable crop protection strategy, and will provide knowledge essential to implement the use of OEs in agriculture, reducing the need for pesticides.

Pertinent Publications of the proponent (last 5 years)

1. Giovannoni M, Lironi D, Marti L, Paparella C, Vecchi V, Gust AA, De Lorenzo G, Nürnberger T, **Ferrari S.** (2021) "The Arabidopsis thaliana LysM-containing Receptor-Like Kinase 2 is required for elicitor-induced resistance to pathogens". *Plant Cell & Environment* 44(12):3545-3562. doi: 10.1111/pce.14192.
2. Lorrai R, Francocci F, Gully K, Martens HJ, De Lorenzo G, Nawrath C, **Ferrari S** (2021) "Impaired cuticle functionality and robust resistance to *Botrytis cinerea* in *Arabidopsis thaliana* plants with altered homogalacturonan integrity are dependent on the class III peroxidase AtPRX71" *Frontiers in Plant Science* 12:696955. https://doi.org/10.3389/fpls.2021.704958
3. Giovannoni M., Marti L., **Ferrari S**, Tanaka-Takada N. Maeshima M., Ott T., De Lorenzo G., Mattei MB, (2021) "The plasma membrane-associated Ca2+- binding protein PCaP1 is required for oligogalacturonide and flagellin-induced priming and immunity" *Plant Cell & Environment* 44(9):3078-3093. doi: 10.1111/pce.14118.
4. Lorrai R, **Ferrari S** (2021) "Host Cell Wall Damage during Pathogen Infection: Mechanisms of Perception and Role in Plant-Pathogen Interactions" *Plants* 2021, 10(2), 399; https://doi.org/10.3390/plants10020399
5. Wang P, Zhou L, Jamieson P, Zhang L, Zhao Z, Babilonia K, Shao W, Wu L, Mustafa R, Amin I, Diomaiuti A, Pontiggia D, **Ferrari S**, Hou Y, He P, Shan L (2020) "Cotton wall-associated kinase GhWAK7A mediates responses to fungal wilt pathogens by complexing with the chitin sensory receptors" *Plant Cell* DOI: https://doi.org/10.1105/tpc.19.00950.
6. Jemmata AM, Ranocha P, Le Rub A, Neela M, Jauneaub A, Raggi S**, Ferrari S**, Burlata V, Dunand C (2020) "Coordination of five class III peroxidase-encoding genes for early germination events of Arabidopsis thaliana". *Plant Sci* 298: 110565. doi: 10.1016/j.plantsi.2020.110565
7. Wu J., Reca IB, Spinelli F, Lironi L, De Lorenzo G, Poltronieri P, Cervone F, Joosten MHAJ, **Ferrari S**[§], Brutus A (2019) "An EFR-Cf-9 chimera confers enhanced resistance to bacterial pathogens by SOBIR1- and BAK1-dependent recognition of elf18." *Mol Plant Pathol.* 20(6):751-764. doi: 10.1111/mpp.12789
8. De Lorenzo G, **Ferrari S**, Giovannoni M, Mattei B, Cervone F (2019) "Cell wall traits that influence plant development, immunity and bioconversion". *Plant J*, 97(1):134-147 doi: 10.1111/tpj.14196.
9. De Lorenzo G, **Ferrari S**, Cervone F, Okun E (2018) "Extracellular DAMPs in Plants and Mammals: Immunity, Tissue Damage and Repair". *Trends Immunol*. 39(11):937-950. doi: 10.1016/j.it.2018.09.006.

References (other than publications of the proponent, if appropriate)