

Advances on Plant-Pathogen Interaction: New Challenges for a Sustainable Disease Management

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1. Introduction

Plant pathogens cause huge losses that have been an important constraint to a worldwide increase of crop production and productivity, aggravated by agricultural intensification and monocultures, leading to new emergent diseases. Relevant efforts have been made in the search to environmentally friendly biocontrol agents, even more once UE directories for commercialization withdrawal of several chemical substances used for pest and disease control, and the new rules established for reducing the agricultural greenhouse gas emissions in the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change.

The European Union, FAO, and the United Nations largely promote and finance projects and programs in order to introduce crop protection principles that can attain sustainable agriculture [1]. However, the development of sustainable plant protection strategies requires new insights into the biology and evolution of the corresponding pathogens and the use of new technologies to augment the efficacy of disease control, bringing new challenges to agriculture production to feed a continuous growing world population. Appropriate management practices and biological control strategies using antagonistic microorganisms may constitute alternative treatments to control plant pathogens, with quite promising prospects for several plant species and pathogens [2,3]. Also, the identification of plant key functional genes involved in plant-pathogen interaction, as well as the understanding of the molecular basis of compatible interactions during pathogen attack, offer great opportunities to apply genetic engineering efforts for incorporation of new sources of resistance for plant protection against pathogens [4,5].

2. Special Issue Overview

The Special Issue of *Biology* “Plant-Pathogen Interaction 2.0” include two original research articles and four reviews, focusing different aspects of plant-pathogen interaction specially in agriculture systems, always looking for the protection of plants against pathogens.

As referred above, the identification of candidate genes in susceptible and resistant responses may facilitate genetic engineering efforts to incorporate new sources of plant resistance/tolerance against pathogens for a sustainable plant-disease management. In the scope of this subject, Campos et al. [6] highlight the importance of genes encoding transcription factors (TFs) in tomato response to pathogens, focusing on different families of TFs, selected for their abundance, importance, and availability of functionally well-characterized members in response to pathogen attack. These authors review tomato TFs’ roles and possibilities related to their use for engineering pathogen resistance in tomato in response to a broad range of pathogens. Focusing on a specific target gene, the work developed by Zhao et al. [7] characterize and functionally analyse the *Triticum aestivum*

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macrophage migration inhibitory factor (*TaMIF1*), whose function was still not known in plants. These authors report an upregulation of *TaMIF1* to *Puccinia striiformis* f. sp. *Tritici* (*Pst*) infection of wheat, with functional analysis revealing that *TaMIF1* was capable of suppressing programmed cell death hinting its role in plant immunity, whilst silencing *TaMIF1* decreased the susceptibility of wheat to *Pst*. The review performed by Rusinque et al. [8] also highlight the importance of genomic tools on the understanding the molecular responses of plants to infection by the nematode *Meloidogyne graminicola*, with transcriptomic analysis identifying several key genes throughout the infection process.

Furthermore, Rusinque et al. [8] focus their review on distribution, biology, identification, and management of the nematode *M. graminicola*, considering the impact that this pathogen on agricultural system, especially on rice production. The review from Bharudin et al. [9] report the search of alternative methods to protect palm oil against a devastating disease predominantly caused by the fungus *Ganoderma boninens*, pointing to the importance of methods used in the disease management, that include cultural practices, chemical treatments and antagonistic microorganism manipulations, proposing future directions to increase the understanding the fungus invasion mechanisms against oil palm. The use of biological control strategies using antagonistic microorganisms as an alternative treatment to control diseases, is also reflected by the research performed by Degani et al. [10]. These authors identify an isolate of *Trichoderma asperellum* with a potential antifungal activity against *Magnaportheopsis maydis*, a fungus responsible for a destructive vascular disease of maize.

Finally an important contribute to the search for alternatives to synthetic agrochemicals is given by Zobir et al. [11]. Looking for alternatives to the higher amount of agrochemical usage to meet the gaps between food production and consumption, with conventional agro-nanochemicals presenting a reduced effectiveness of the active ingredient in reaching the target, that affect the environment and life, these authors provide an overview on the current status of the host–guest supramolecular chemistry of nanopesticides to combat various pests for plant protection.

In this context, the Special Issue “Plant-Pathogen Interaction 2.0” brings new advances to unravel the complexity of plant–pathogen interactions, with a special focus on the search for sustainable methods to protect plants against pathogens.

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