

Article

Isolation, Identification, and Biocontrol Potential of Root Fungal Endophytes Associated with Solanaceous Plants Against Potato Late Blight (*Phytophthora infestans*)

Abbas El-Hasan^{1,*}, Grace Ngatia¹, Tobias I. Link¹ and Ralf T. Voegelé¹¹ Department of Phytopathology, Institute of Phytomedicine, Faculty of Agricultural Sciences, University of Hohenheim, Otto-Sander-Str. 5, D-70599 Stuttgart, Germany;

* Correspondence: aelhasan@uni-hohenheim.de; Tel.: +49 711 459 22392 (A.E.-H.).

Supplementary Materials

Citation: El-Hasan, A.; Ngatia, G.; Link, T.I.; Voegelé, R.T. Isolation, Identification, and Biocontrol Potential of Root Fungal Endophytes Associated with Solanaceous Plants against Potato Late Blight (*Phytophthora infestans*). *Plants* **2022**, *11*, 1605. <https://doi.org/10.3390/plants11121605>

Academic Editors: Špela Mechora and Dragana Šunjka

Received: 1 June 2022

Accepted: 14 June 2022

Published: 18 June 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Table S1. Characteristics of sampling regions.

Sampling region	Geographic coordinates	Altitude (m asl ^a)	Rainfall ^b (mm)	Soil properties			Soil types
				pH	EC ^c	OM ^d	
Kilifi	3°38'S 39°51'E	8	942	7.4 – 7.6	0.02 – 0.52	0.7 – 2.0	Luvisols
Kiambu	1°14'S 36°39'E	2073	893	6.5 – 6.9	0.05 – 0.12	1.2 – 3.4	Nitisols, Andosols
Nyandarua	0°42'S 36°39'E	2540	1219	5.3 – 7.0	0.05 – 0.14	5.3 – 7.0	Cambisols, Glaysols

^{a)} above sea level, ^{b)} annual average, ^{c)} EC: electrical conductivity in $\mu\text{S}/\text{cm}$, ^{d)} OM: organic matter.



Figure S1. Isolation of fungal root endophytes. **a)** Endophytic fungi emerging from cultured roots, **b)** Clean short press plate, and **c)** Contaminated short press plate.

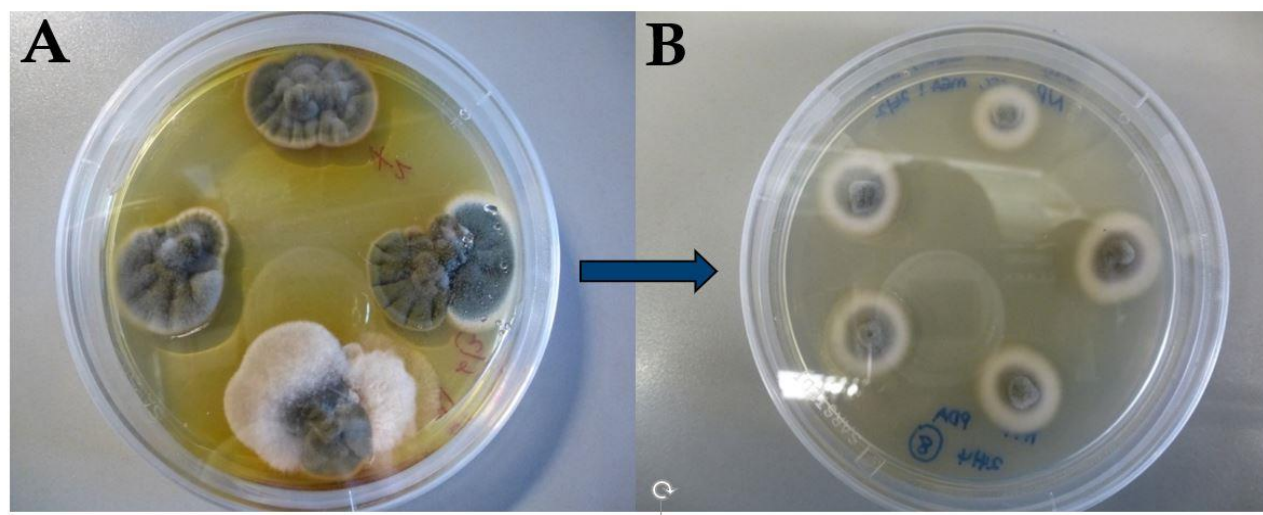


Figure S2. Isolation of fungal root endophytes from solanaceous plants. **A)** Endophytic fungi arising from cultured roots, and **B)** Pure fungal colonies.



Figure S3. Isolation of *P. infestans*. (a) *P. infestans* mycelia growing on the surface of an inoculated potato tuber slice, (b) Pure colony of *P. infestans* on 20 % V8 agar, and (c) Mycelia of *P. infestans* on potato leaflets inoculated with the pathogen.

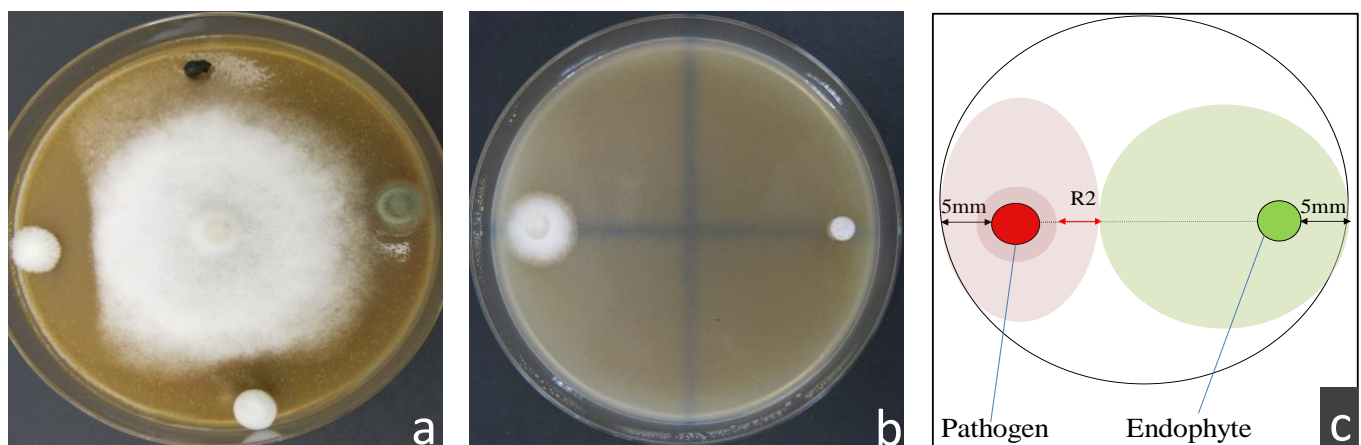


Figure S4. Dual antagonistic assay of fungal endophytes and *P. infestans*. (a) Co-culture of *P. infestans* (center colony) with four root endophytes to screen for activity against the pathogen's mycelia, (b) Setup of dual culture assay on the introduction of an endophyte 72 h after *P. infestans* (left colony) inoculation and, (c) Schematic representation of the measurement (R2) used in calculating percentage of inhibition.