



The rhizosphere: a playground and battlefield for soilborne pathogens and beneficial microorganisms

Jos M. Raaijmakers, Timothy C. Paulitz, Claude Alabouvette, Yvan Moëgne-Loccoz

► To cite this version:

Jos M. Raaijmakers, Timothy C. Paulitz, Claude Alabouvette, Yvan Moëgne-Loccoz. The rhizosphere: a playground and battlefield for soilborne pathogens and beneficial microorganisms. Rhizosphere: achievements and challenges, 104, Springer Science + Business Media B.V., 536 p., 2010, Developments in Plant and Soil Sciences, 978-90-481-2855-6. hal-02928760

HAL Id: hal-02928760

<https://hal.inrae.fr/hal-02928760>

Submitted on 2 Sep 2020

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Yves Dessaux
Philippe Hinsinger
Philippe Lemanceau
Editors

DEVELOPMENT IN PLANT AND SOIL SCIENCES 104

Rhizosphere: Achievements and Challenges

 Springer

Described by Hiltner over a century ago (1904), the rhizosphere is defined as the fraction of soil influenced by plant root activities. This dynamic, complex interface where soil, plant roots and microbes interact is a major hotspot of microbial activity, where numerous subtle molecular processes, as well as multiple feedback events take place. Rhizosphere investigations at the microscopic scale have driven spectacular academic advances in the fields of soil sciences or plant-microbe interactions. They bear promises in terms of environmentally-friendly procedures such as bioremediation or ecological engineering. The long recognized role of rhizosphere processes in plant nutrition and health, and more generally in plant adaptation to stress conditions, is now becoming central for designing sustainable management practices of agricultural and forest ecosystems. The rhizosphere, however, must also be considered and investigated at a much larger scale than its own, especially as a location where important steps of both carbon and nitrogen cycles occur, with obvious links with global changes. Major advances in understanding the rhizosphere have been achieved over the last two decades. Combined expertise in plant biology, microbial ecology and soil sciences and design of research strategies including the latest innovative methods in these fields opens exciting prospects for the future.

Reprinted from *Plant and Soil*, Vol. 321, nos 1-2

ISBN 978-90-481-2855-6



9 789048 128556

> springer.com

Yves Dessaux · Philippe Hinsinger · Philippe Lemanceau
Editors

Plants and Soil

Reprinted from *Plant and Soil*, Vol 321, nos 1-2.

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Editors

Yves Dessaux
CNRS, Inst. Sciences du Végétal (ISV)
avenue de la Terrasse,
91198 Gif-sur-Yvette, France

Philippe Hinsinger
INRA – SupAgro, UMR 1222 Biogéochimie du,
Sol et de la Rhizosphère, place Viala,
34060 Montpellier, France

Philippe Lemanceau
Université Bourgogne, INRA-CMSE,
UMR 1229 Microbiologie du, Sol et de,
21065 Dijon, France

Cover caption:

Background photograph: Fababean (*Vicia faba* L.) grown in the long-term P-fertilizer field trial at Aùzeville (INRA Toulouse), exhibiting roots with N₂-fixing nodules, abundant roots hairs and adhering soil, i.e. key players and features in the rhizosphere of legumes (photograph by P. Hinsinger).

Left insert photograph: *In situ* detection of *gfp*-tagged *Pseudomonas* sp. DSMZ 13134 cells on root surface of barley (*Hordeum vulgare* L.) using the CLSM (confocal laser scanning microscope LSM510, Carl Zeiss, Jena, Germany). Two-day old seedlings were inoculated with a bacterial suspension (10⁸ cells per seedling). Plants were grown for two weeks in agricultural soil in pots in a greenhouse before analysis of the root colonization. Autofluorescent soil particles can be seen in the upper right corner (courtesy of K. Buddrus-Schiemann, Helmholtz Zentrum München, Neuherberg, Germany).

Right insert photograph: *In situ* detection of bacterial cells on the root surface of potato (*Solanum tuberosum* L.) grown under field conditions four weeks after planting. Fluorescence *in situ* hybridization (FISH) was performed using the oligonucleotide probe EUB-338-mix labeled with Fluos. Bacterial cells appear with the CLSM as green fluorescent signals and a clay particle can be seen as redish autofluorescence (courtesy of K. Buddrus-Schiemann, Helmholtz Zentrum München, Neuherberg, Germany).

ISBN: 978-90-481-2855-6 eISBN: 978-90-481-2857-0

DOI: 10.1007/978-90-481-2857-0

Library of Congress Control Number: 9789048128556

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