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Minireview

Mycorrhizal fungal establishment in agricultural soils: factors determining inoculation success

Author for correspondence:
Erik Verbruggen
Tel: +49 30 838 53163
Email: erikverb82@hotmail.com

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Erik Verbruggen[1], Marcel G. A. van der Heijden[2,3,4], Matthias C. Rillig[1] and E. Toby Kiers[5,6]

[1]Plant Ecology, Institute of Biology, Freie Universität Berlin, Altensteinstr. 6, D-14195, Berlin, Germany; [2]Ecological Farming Systems, Research Station ART, Agroscope Reckenholz Tänikon, Zürich, Switzerland; [3]Plant–Microbe Interactions, Institute of Environmental Biology, Faculty of Science, Utrecht University, 3508, TB Utrecht, The Netherlands; [4]Institute of Evolutionary Biology and Environmental Studies, University of Zürich, Zürich, Switzerland; [5]Department of Ecological Science, Faculty of Earth and Life Sciences, VU University, Amsterdam, The Netherlands; [6]Department of Plant, Soil and Insect Science, University of Massachusetts, Amherst, MA, USA

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Summary

Soil biota provide a number of key ecological services to natural and agricultural ecosystems. Increasingly, inoculation of soils with beneficial soil biota is being considered as a tool to enhance plant productivity and sustainability of agricultural ecosystems. However, one important bottleneck is the establishment of viable microbial populations that can persist over multiple seasons. Here, we explore the factors responsible for establishment of the beneficial soil fungi, arbuscular mycorrhizal fungi (AMF), which can enhance the yield of a wide range of agricultural crops. We evaluate field application potential and discuss ecological and evolutionary factors responsible for application success. We identify three factors that determine inoculation success and AM fungal persistence in soils: species compatibility (can the introduced species thrive under the imposed circumstances?); field carrying capacity (the habitat niche available to AMF); and priority effects (the influence of timing and competition on the establishment of alternative stable communities). We explore how these factors can be employed for establishment and persistence of AMF. We address the importance of inoculum choice, plant choice, management practices and timing of inoculation for the successful manipulation of the resulting AMF community.

Introduction

One of the greatest challenges of the 21st Century is to feed an increasing world population without exacerbating current environmental problems (Fitter, 2012). One promising approach is to increase the utilization efficiency of scarce nonrenewable fertilizers. This has the potential to simultaneously increase plant productivity and reduce pressures on the environment. Soil microbes offer largely unexplored potential to increase agricultural yields and productivity in a low-input manner.

Erik Verbruggen was a finalist for the 2012 *New Phytologist* Tansley Medal for excellence in plant science, which recognises an outstanding contribution to research in plant science by an individual in the early stages of their career; see the Editorial by Dolan, **197**: 1025–1026

Evolutionary and ecological research is unveiling the various mechanisms by which soil microbes can stimulate plant productivity (Van der Heijden *et al.*, 2008). In particular, rhizosphere symbionts named arbuscular mycorrhizal fungi (AMF) have received considerable attention as a potential low-input solution to increasing the nutrient uptake efficiency of crop hosts. The majority of plant species, including most agricultural crops, enter into a symbiosis with mycorrhizal fungi, exchanging plant sugars for fungal-derived nutrients, such as phosphorus and nitrogen. Apart from nutritional benefits, they are also known to increase soil structure and suppress diseases.

Given the potential benefits to agricultural productivity (see Lekberg & Koide, 2005 for a review), it is not surprising that manipulation of AMF communities (either by inoculation with particular strains or through management of resident