Go to
Table of Contents

BENEFICIAL INTERACTIONS BETWEEN PLANTS AND SOIL MICROBES

S. Ravnskov
Department of Agroecology, Aarhus University, Research Centre Flakkebjerg, DK-4200 Slagelse, Denmark. Email: Sabine.Ravnskov@agrsci.dk

ABSTRACT. The microbial community in the rhizosphere plays a key role in plant growth and -health, either directly by influencing plant nutrient uptake and by causing disease, or indirectly via microbial interactions in the rhizosphere. The majority of field grown crops (70-80 %) naturally form symbiosis with Arbuscular Mycorrhizal Fungi (AMF); thus the relation between root pathogens and most plants under field conditions is an interaction between AM and pathogens. The AM symbiosis has functionally been characterised as the reciprocal exchange of nutrients between the symbionts: the fungus is obligate biotrophic, whereas the plant receives inorganic nutrients from the AMF. However, the antagonistic potential of AMF against a range of soil-borne pathogens has also been demonstrated, but the underlying mechanisms are unknown. Both direct competition for nutrients/space or antibiosis have been suggested, as indirect competition by AM fungi, changes of plant root structure, root-exudations, nutrient uptake and growth as well as AMF induction of plant defence have been investigated. Moreover, a bacterial community structure associated to AM structures has been demonstrated and some of these bacteria have shown antagonistic potential against pathogens. This raises the question whether it is the AMF or the associated bacteria, which control the pathogens. So far, a general mechanism for AMF control with soil-borne pathogens has not been identified, but investigations of more mechanisms and interplays between them might be the answer.

INTRODUCTION

Root associated microorganisms play a key role in plant growth and –health and thereby affects crop production. Due to loss of yield and impaired quality caused by plant pathogens, intensive research has been performed to study the biology and control of soil-borne pathogens in crop production. While it is well-known that plant beneficial microorganisms as e.g. Rhizobium and Arbuscular Mycorrhizal (AM) fungi can influence nutrient uptake, growth and health of their associated plants, the role of plant beneficial microorganisms in relation to yield and quality has received less attention. .

AM symbiosis. The majority of field grown crops (70-80 %) naturally form symbiosis with AM fungi. The relation between plant and (a)biotic soil environment is therefore for most plants based on an interaction between AM and soil (1). AM symbiosis has functionally been characterised as the reciprocal exchange of nutrients between the symbionts: the fungus is obligate biotrophic and receives carbon from the plant, whereas the plant receives inorganic nutrients, especially P, from the AM fungus (2). AM fungi can be considered as an ecosystem service for plant production (1), and several studies have demonstrated an antagonistic potential of AM fungi against soil borne pathogens (3).

Antagonistic potential of AM against oomycetes. AM fungi have shown to have an antagonistic potential against oomycetes in different crops (4, 5, 6, 7). Accordingly, a negative correlation between the abundance of AM fungi in roots and disease severity index of pea plants has been demonstrated (8). Carlsen et al 2008 (5) demonstrated that an AM fungus, *Glomus mosseae*, totally excluded *Pythium ultimum* from clover roots. However, the mechanism(s) underlying the antagonistic potential of AM against oomycetes is unknown.

Mechanisms underlying the antagonistic potential of AM against oomycetes. Several hypotheses explaining AM control of soil-borne pathogens have been proposed. For instance, direct competition between AM fungi and *Aphanomyces eutheichus* (4) or *Pythium ultimum* (9), resulting in decreased pathogen biomass, has been demonstrated. Moreover, it has been hypothesised that induction of the plant defence system by AM fungi with subsequent increased plant tolerance against pathogens could explain AM fungal control with soil-borne pathogens. However, Carlsen et al 2008 (5) showed that the production of several secondary metabolites in AM clover infected with *P. ultimum* depended on the combination of clover variety and AM fungal species in the symbiosis, highlighting the difficulty to draw conclusions on AM fungal induction of plant defence as a general mechanism. Finally, it has been demonstrated that the bacterial community associated with AM-roots is different from the bacterial community associated with the environment of non-mycorrhizal roots (10), and it was hypothesised that these AM-associated bacteria play a role in the antagonistic potential of AM fungi against soil-borne pathogens. Li et al 2007 (6) studied the effect of AM associated *Paenibacillus* sp. against *P. aphanidermatum* in cucumber roots and found a biocontrol effect indicating that the potential of the AM fungus to control *P. aphanidermatum* could be related to the AM associated bacteria.

CONCLUSIONS

Plant beneficial microorganisms including AM fungi play a key role in plant production. A more profound knowledge on the function of AM fungi in relation to plant health might help exploit AM fungi as an ecosystem service. The mechanisms underlying the antagonistic potential of AM fungi against soil-borne pathogens still need more investigations.

ACKNOWLEDGEMENTS

I would like to thank the organizers of the 7th Australasian Soil Diseases Symposium for inviting me to present our work.

REFERENCES

1. Smith FA. and Smith SE. (2011) Plant Soil 348:63–79
2. Smith, SE, Jakobsen I, Grønlund M, Smith FA. (2011) Plant Physiol 156(3): p. 1050-1057.
3. Whipps, J.(2004) Can. J. Bot. 82, 1198–1225.
4. Thygesen K, Larsen J, Bødker L. 2004. Eur J Plant Pathol 110:411-419
5. Carlsen SCK, Understrup A, Fomsgaard IS, Mortensen AG, Ravnskov S. (2008) Plant Soil 302:33-43.
6. Li B, Ravnskov S, Xie G, Larsen J. (2007) BioControl 52:863-875.
7. Larsen J, Graham J, Cuberon J, Ravnskov S. (2012) Eur J Plant Pathol 133:361-369
8. Yu L, Nicolaisen M, Larsen J, Ravnskov S. (2012) Plant and Soil. DOI 10.1007/s11104-012-1180-0
9. Larsen J, Ravnskov S, Jakobsen I. (2003). Folia Geobotanica 38: 145-154.
10. Mansfeld-Giese K, Larsen J, Bodker L (2002) FEMS Microbiol Ecol . 41; 133-140.