In the years since the first edition of “Arbuscular Mycorrhizas: Physiology and Function” was published, an exceptional proliferation of interest in mycorrhizal biology has developed. This has been associated with advances in different research disciplines such as genetics, genomics, proteomics, metabolomics and physiology, advances which have generated better insight into topics of mycorrhizal biology, including the mechanisms of host-mycorrhiza interactions pre- and post-penetration, the influence of the symbiosis on the host and its surroundings, and the evolution and diversity of mycorrhization. It therefore became necessary to both update and expand the book’s coverage in this, its second edition.

In the second edition of this book, we wanted to retain the unique angle of our original goal of bringing the reader a state-of-the-art multidisciplinary view of arbuscular mycorrhiza (AM) – plant interactions, beginning with pre-penetration stages, through colonization, symbiotic function, influence of the symbiosis on the host and its surroundings, and ending with evolution and diversity of mycorrhization. To this aim, we have recruited leading scientists in their fields to provide a thorough and detailed review of the current status of scientific knowledge on mycorrhizal biology.

The subject of host–fungal interactions during the pre-penetration stage of AM is discussed in the first four chapters of the book. The first chapter, a review by Manuela Giovannetti, Luciano Avio and Cristiana Sbrana, presents the physiological and genetic aspects of AM fungal spore germination and pre-symbiotic mycelial growth. This chapter focuses on new insights into the main fungal developmental switches in the absence of the host; it promotes resolution of an interesting enigma: despite a putative strong selective disadvantage, how do these obligate symbionts compensate for the lack of host-regulated spore germination?

The chapter by Gerald Nagahashi, David D. Douds and Yurdagul Ferhatoglu presents a study of metabolites identified in separated exudate fractions of carrot roots grown under phosphorus stress, and their potential role in AM fungus-host interactions is suggested. This study provides a more general picture of the types of compounds exuded by host roots, which affect the growth of AM fungi.

Andrea Genre and Paola Bonfante discuss some of the responses that are induced in root cells during the different steps of AM colonization. Interestingly,
the establishment of a functional symbiosis appears to lie at the end of a series of
plant-controlled checkpoints; each of these checkpoints is required but not suffi-
cient to achieve the next one.

The chapter by Soizic Rochange focuses on strigolactones and their role in AM
symbiosis. A group of carotenoid-derived metabolites exuded by plant roots,
strigolactones, have recently been recognized as major contributors to the establish-
ment of mycorrhizal symbiosis. This chapter presents recent advances and future
prospects in our knowledge of the structural features of strigolactones, their biosyn-
thetic pathway and their mode of action.

The next subject in the book is host–fungal interactions post-host penetration by
the mycorrhizal fungi. The chapter by Philipp Franken presents molecular and
physiological aspects of AM symbiosis post-penetration. Different strategies that
have been taken to understand the molecular-physiological basis of the symbiosis
are described, including non-targeted and function-targeted approaches. The
described studies lead to new hypotheses concerning mycorrhizal functioning.

The chapter by Maria Harrison, Nathan Pumplin, Florence J. Breuillin, Roslyn
D. Noar, and Hee-Jin Park focuses on a specific, yet crucial component of mycor-
rhizal symbiosis, that of phosphate transport. For across-membrane symbiotic Pi
transfer, transport proteins of both the AM fungus and plant are needed. Recent
progress in the identification of plant and fungal Pi-transporter proteins, their
expression patterns and roles in AM symbiosis are presented.

Elke Neumann and Eckhard George present AM fungal symbiosis as a plant
nutrient-acquisition strategy. Both direct and indirect effects of AM mycelia on
plant nutrient availability and uptake are presented. The integration of AM fungal
symbiosis into particular plant nutrient-acquisition strategies is discussed, as well
as the contribution of the subject to our understanding of ecosystem functioning,
and implications as to further development of mycorrhizal technology for plant
production.

The chapter by Jutta Ludwig-Müller presents the subject of hormonal responses
in host plants that are triggered by AM fungi. Major advances in our knowledge of
the functions of phytohormones in AM development are presented, along with
thoughts on the effects of belowground signals on aboveground tissues and the pos-
sible role of the effecting hormones in the upper part of the plant.

The subject of influences of AM symbiosis on the host and its surroundings is
divided into two sub-topics: host responses to biotic stress, and host responses to
abiotic stress. María J. Pozo, Sabine C. Jung, Juan A. López-Ráez and Concepción
Azcón-Aguilar discuss the impact of AM symbiosis on plant defense responses to
biotic stress. They highlight the mechanisms that may be involved in particular
cases and elaborate on a general modulation of plant defense responses in mycor-
rhizal systems.

Another aspect of the effect of mycorrhiza on host responses to biotic stress is
mediated via the biotic environment of AM fungi in soil. This subject, covered by
Jan Jansa and Milan Gryndler, presents AM fungus interactions with soil and in
particular with other soil microbes. It is suggested that AM fungi play an important
role as a carbon and nutrient highway between the plants and the soil, whereas both
AM fungi and plant root physiology are affected by biologically active substances produced by the soil biota.

The influence of the symbiosis on host responses to abiotic stress is presented in the book in the following chapters. The chapter by Juan Manuel Ruiz-Lozano and Ricardo Aroca presents host responses to osmotic stresses, including stomatal behavior and water-use efficiency of AM plants. Here, a combination of physiological, biochemical and environmental conditions provides detailed insight into the mechanism of AM symbiosis’s ability to protect host plants against the detrimental effects of water deficit, caused by osmotic stresses such as drought and salinity.

The chapter by Katarzyna Turnau, Przemysław Ryszka, and Grzegorz Wojtczak presents the issue of metal tolerance in mycorrhizal plants, in heavy-metal-rich, industrial waste lands in temperate regions. The role of mycorrhizal fungi in phytoremediation of these regions is presented, for both heavy-metal detoxification and the establishment of vegetation in strongly polluted areas; the importance of selection of both plant and fungal partners for the effectiveness of bioremediation is emphasized.

Evolutionary and diversity perspectives of mycorrhizal associations are presented in the last two chapters of the book. Victoria Estaún, Cinta Calvet and Amèlia Camprubí describe the effect of differences among crop species and cultivars on AM symbiosis. Interestingly, despite decades of breeding new varieties with no consideration for the presence or role of AM symbiosis, such symbiosis persists. However, differences in diverse plant species’ responsiveness to, and dependence on the symbiosis have been found. A holistic approach to breeding crop cultivars is suggested that will make full use of AM symbiosis.

Roger T. Koide presents the subject of mycorrhizal symbiosis and plant reproduction. Several aspects of sexual reproduction that may be affected by mycorrhiza are presented. Interestingly, mycorrhiza are suggested to lead to variations among individual plants in their contributions to the next generation. As a result, mycorrhiza may control the genetic structures of populations and communities.

We feel that the unique combination of subjects brought together in this book provides a thorough and detailed picture of the updated knowledge on mycorrhizal symbiosis biology. Many new notions of mycorrhizal symbiosis are raised, as well as future prospects on mycorrhizal effects and their management. We are grateful to the authors who contributed these book chapters, for sharing their knowledge, vision and thoughts; we thank the dedicated anonymous reviewers who improved the book’s quality. We hope that this book will serve as a basis for upcoming scientific advances in mycorrhizal studies, promoting future understanding of this symbiosis and utilization of its benefits.

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Cover: Micrographs showing differential staining of mycelium originated by *Glomus mosseae* spores growing in the absence of the host by Manuela Giovannetti, Luciano Avio and Cristiana Sbrana
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