THE ECOPHYSIOLOGY OF PLANT-PHOSPHORUS INTERACTIONS

Plant Ecophysiology

Volume 7

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Aims & Scope:

The Springer Series in *Plant Ecophysiology* comprises a series of volumes that deals with the impact of biotic and abiotic factors on plant functioning and physiological adaptation to the environment. The aim of the *Plant Ecophysiology* series is to review and integrate the present knowledge on the impact of the environment on plant functioning and adaptation at various levels: from the molecular, biochemical and physiological to a whole plant level. This series is of interest to scientists who like to be informed of new developments and insights in plant ecophysiology, and can be used as advanced textbooks for biology students.

The titles published in this series are listed at the end of this volume.

The Ecophysiology of Plant-Phosphorus Interactions

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CONTENTS

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PREFACE

The Ecophysiology of Plant-Phosphorus Interactions is the seventh volume in the *Plant Ecophysiology* series. It reviews the current state of knowledge, concepts and research of plant-phosphorus interactions in natural and managed ecosystems together with aspects of the phosphorus nutrition of crop plants, addressing in particular the sustainability and possible environmental consequences of agricultural production.

Phosphorus (P) is an essential macronutrient for plant growth. Plants take up P as phosphate (Pi) from the soil solution. Since little Pi is available to plants in most soils, they have evolved mechanisms to acquire and use P efficiently and foster symbiotic relationships to help them acquire P sources beyond their immediate range. Whilst in agricultural systems P limitations are frequently overcome by the application of P-fertilizers, these may cause environmental pollution and the use of inorganic Pi is unsustainable. The genetic and phenotypic variation among plants adapted to ecosystems with low P availability provides an opportunity to improve our understanding of plant responses to P limitation and this knowledge could be utilized to develop crop varieties with better P use for agriculture.

In the first chapter of this volume, Holm Tiessen places P in a global context. He reviews the geochemistry of P, the cycling of P in the environment, the effects of humans on P cycles, and their consequences. Next, Karl Niklas describes the allometric relationships between tissue C, N and P concentrations among and within plant species, and explores the implications of these for various physiological, ecological and evolutionary phenomena. Gabrielle Thiébaut explains how P is acquired by aquatic plants and how P supply and seasonal fluctuations in P loads affect the abundance and distribution of aquatic plant species, while Philip White and John Hammond summarize the requirements and functions of P in terrestrial plants and the impacts of P availability on their ecology. These authors also introduce the biochemical, physiological and morphological traits that enable terrestrial plants to acquire and utilize P most effectively, and how the expression of these traits might be regulated by plant P status.

Jonathan Lynch and Kathleen Brown focus on the root traits that provide an adaptive strategy for P acquisition by terrestrial plants, which include: greater root biomass allocation, changes in root architecture to exploit local P patches, increased root length density, proliferation of root hairs, symbiosis with mycorrhizal fungi and the secretion of organic acids and phosphohydrolases. This theme is continued

by Carroll Vance, who addresses the adaptations for the acquisition and use of P in plants lacking effective mycorrhizal symbioses, concentrating on species that develop specialized complex roots (cluster and dauciform) and on Arabidopsis. These chapters are complemented by those of Jose Barea and colleagues, who describe the nature of plant-mycorrhizal symbioses and their impact on plant productivity, plant community structure and P cycling in the environment, and of Petra Marschner, who provides an overview of the influence of rhizosphere microorganisms on the growth and P nutrition of plants. These chapters describe the major influence of plant species on rhizosphere community composition, and discuss the possible reasons for this. They also discuss the use of microbial inoculants to improve plant productivity.

The role of P-fertilizers in agriculture is reviewed by Ernest Kirkby and Johnny Johnston, who emphasize the necessity of P-fertilizers for crop production and reflect on their environmental and ecological footprint. Against the backdrop of depleting Pi reserves, and the necessity for global food security, they establish strategies for more efficient use of soil and fertilizer P based on knowledge of the behavior of P in soils, the introduction of best management practices and the potential for developing "P-efficient" cultivars of crop plants. These strategies are further explored in chapters by John Hammond and Philip White, who describe how the application of P-fertilizers to crop plants can be optimized by monitoring and modeling the P status of soils and plants, and by Tim George and Alan Richardson, who describe how appropriate breeding and transgenic approaches can be used to improve crop P acquisition. The volume concludes with a thought-provoking perspective by John Raven on the past and future P-nutrition of plants, which includes a checklist of priorities for immediate action to enable the world to feed its burgeoning human population.

It is hoped that this book will be of interest to students and researchers studying all aspects plant-phosphorus interactions: omicists, physiologists, ecologists and all readers interested in sustainable crop production.

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