Preface

The adaptation and evolution of terrestrial plants depend, to a large extent, on their ability to acquire nutrients. Therefore, factors governing plant nutrient acquisition are central to our understanding of plant ecology and evolution. The mechanisms that control plant nutrient uptake and how plants respond to changes in the environment have helped our understanding of the forces that govern today's plant communities, and are also likely to be indispensable in models designed to predict how plant communities will respond to projected changes in the global climate. A modern and integrated treatment of these mechanisms is the motivation for the production of this volume. Even though there are other excellent books that deal with plant nutrition (e.g., Barber 1995; Marschner 1995; Tinker and Nye 2000), a number of major differences make the content of this volume very timely.

First, this volume does not deal with the broader concept of plant nutrition. Rather, the emphasis here is on factors that control plant nutrient acquisition. Recent methodological advances in the imaging of root growth, architecture and turnover, as well as isotope techniques, have rapidly filled the information gap that once hindered progress in our understanding of the patterns and mechanisms of nutrient acquisition by native terrestrial plants. This volume reflects on many of those mechanisms and patterns. Second, and perhaps more important, other books in this area often discuss nutrient uptake by plants from an agronomic perspective. In contrast, the focus of this volume is largely ecological. Consequently, many of the chapters discuss root system characteristics that have evolved to cope with conditions that are only rarely experienced by crop plants, e.g., heterogeneity of soil nutrients in time and space.

Given the importance of the factors that control available nutrients at the root surface, we devoted two chapters to soil nutrient bioavailability. Chapter 1 deals with soil physiochemical factors and Chapter 2 with biogeochemical nutrient cycling controlling the release of nutrients from soil organic reservoirs. Chapter 3 highlights soil spatial and temporal heterogeneity of nutrient bioavailability. Nitrogen fixation and its contribution to soil N availability are covered in Chapter 4. Chapter 5 addresses the regulation of nutrient uptake by internal plant demand and use efficiency. The focus of the remaining chapters is on root characteristics, particularly those that are to date understudied, e.g., kinetics of uptake (Chap. 6), architecture (Chap. 7), life span (Chap. 8), and mycorrhizal symbiosis (Chap. 9). Two further chapters deal with nutrient uptake and how it responds to key components of global change. Chapter 10 deals with changes in root zone temperature, whereas Chapter 11 considers plant nutrient uptake responses to changes in UV-B, ozone, and atmospheric CO_2 concentration. Finally, Chapter 12 presents a synthesis of the book, emphasizing the need for an integrated view of plant nutrient uptake based in particular on molecular biology and biogeochemistry.

Most chapters have a nitrocentric/nitrophilic perspective, reflecting the fact that the literature is dominated by studies of plant nitrogen uptake. This focus is justified, given the N limitation of primary productivity in many native systems. There is growing recognition, however, that the balance between the availability of N and other nutrients, e.g., N to P ratios (Aerts and Chapin 2000), or the availability of micronutrients (Hungate et al. 2004) may be more critical components of plant nutrition than N dynamics alone.

It was noted above that an adequate treatment of topics such as soil physical and chemical factors, which have received only limited coverage here, would require its own volume. Several other areas fall outside the scope of this book, but are indispensable to the understanding of nutrient intake by plants. For example, this volume covers very little about recent methodological approaches in field nutrient uptake studies. Advances in stable isotope technology and affordability have made stable isotopes a popular approach in assessing nutrient uptake. Also, ion uptake into the root, and its eventual transport to the shoot, are influenced by root anatomical characteristics, but this field remains incredibly understudied. Readers interested in this area of research are referred to McCully (1995), Clarkson (1996), and Peterson et al. (1999) for issues and perspectives on anatomical and structural aspects of roots that control nutrient uptake. The readers are also encouraged to examine a recent volume of the Ecological Studies Series edited by de Kroon and Visser (2003), whose content is very complementary to this book.

Finally, compiling this volume represents the efforts of more than just one person. This work would not have been possible without the input from my co-authors who were extremely patient with me. Due to an inevitable lag associated with the production of the book, some of the very newest literature may not appear in the various chapters. However, every effort has been made to reduce this citation gap to a minimum. In particular, I thank Vince Gutschick and John Lussenhop who provided numerous feedback on many issues per-

taining to nutrient uptake by plants. Last, but not least, I owe much to Jacqueline Charette-BassiriRad who devoted considerable time helping me with various editorial aspects.

Chicago, March 2005 *Hormoz BassiriRad*

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