

5 Modelling P dynamics in the soil plant system

Andrea Schnepf^{1,*}, D. Leitner¹, S. Klepsch^{1,2}, S. Pellerin³, A. Mollier³

¹BOKU – University of Natural Resources and Applied Life Sciences, Vienna, Department of Forest- and Soil Sciences, Institute of Soil Science, Peter Jordan Strasse 82, A-1190 Vienna, Austria. Email: [andrea.schnepf, sabine.klepsch, daniel.leitner]@boku.ac.at.

²AIT Austrian Institute of Technology, Department of Health & Environment, 2444 Seibersdorf, Austria, Email: sabine.klepsch@boku.ac.at

³National Institute for Agricultural Research (INRA), Department for the Environment and Agronomy, Joint Research Unit for Soil Plant transfer and cycle of nutrients and trace elements (TCEM), 71, Avenue Edouard Bourlaux, BP 81, F-33883 Villenave , d'Ornon, France. Email: [pellerin, mollier]@bordeaux.inra.fr.

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Abstract

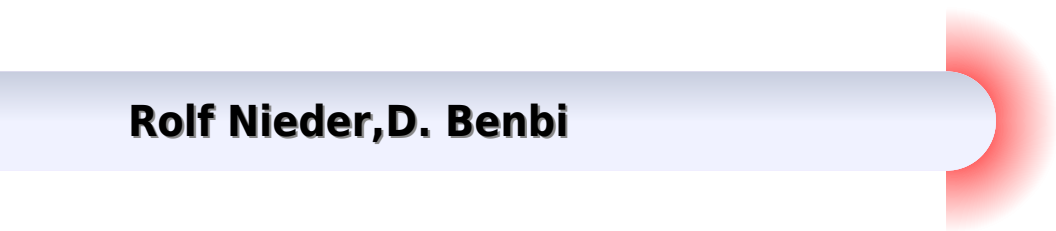
The importance of phosphorus as both sparingly mobile essential nutrient and pollutant is reflected by the large number of P models at different scales and with different purposes. In this chapter, give an overview on models of P dynamics and generally discuss the approach to developing a mathematical model. Then, we demonstrate this concept by means of four case studies that focus on different plant traits that enhance plant phosphate uptake from soil. The first case study presents a model for phosphate uptake by a mycorrhizal root; the second case study shows a model for time-varying root exudation on the single root scale; the third case study is based on a root system scale model that includes root plasticity, and the fourth case study presents a model for crop response to soil phosphate supply.

5.1 Introduction

The importance of phosphorus (P) as both sparingly mobile essential nutrient and pollutant (e.g. Jones and Oburger 2009) is reflected by the large number of P models at different scales and with different purposes. P dynamics have been studied at a wide range of spatial scales. Examples include the global scale (Harrison et al. 2005), watershed scale (Radcliffe et al. 2009), ecosystem scale (Schlecht and Hiernaux 2005), farming systems scale (Schils et al. 2007), field scale (Schoonmans and Groenendijk 2000; Torbert et al. 2008), whole plant scale (Mollier et al. 2008), soil profile scale (Roose and Fowler 2004), and single root scale (Kirk 1999; Roose et al. 2001). In Figure 5.1, we show various P models in a space-time diagram. The position in the space time diagram illustrates the main temporal and spatial scale of application. A full symbol means that this specific model includes smaller-scale submodels. The colour illustrates whether the model is mechanistic or empirical, deterministic or stochastic. Most of the models are mechanistic and deterministic; the degree of empiricity generally increases with spatial scale.

Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant

Rolf Nieder, D. Benbi



Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant:

Phosphorus in Action Else K. Bünemann, Astrid Oberson, Emmanuel Frossard, 2010-11-08 Phosphorus P is a finite resource which is essential for life It is a limiting nutrient in many ecosystems but also a pollutant which can affect biodiversity in terrestrial ecosystems and change the ecology of water bodies This book collects the latest information on biological processes in soil P cycling which to date have remained much less understood than physico chemical processes The methods section presents spectroscopic techniques and the characterization of microbial P forms as well as the use of tracers molecular approaches and modeling of soil plant systems The section on processes deals with mycorrhizal symbioses microbial P solubilization soil macrofauna phosphatase enzymes and rhizosphere processes On the system level P cycling is examined for grasslands arctic and alpine soils forest plantations tropical forests and dryland regions Further P management with respect to animal production and cropping and the interactions between global change and P cycling are treated

Handbook of Processes and Modeling in the Soil-Plant System Rolf Nieder, D. Benbi, 2024-11-01 Learn to create and use simulation models the most reliable and cost effective tools for predicting real world results The Handbook of Processes and Modeling in the Soil Plant System is the first book to present a holistic view of the processes within the soil plant atmosphere continuum Unlike other publications which tend to be more specialized this book covers nearly all of the processes in the soil plant system including the fundamental processes of soil formation degradation and the dynamics of water and matter It also illustrates how simulation modeling can be used to understand and forecast multiple interactions among various processes and predict their environmental impact This unique volume assembles information that until now was scattered among journals bulletins reports and symposia proceedings to present models that simulate almost all of the processes occurring in the soil plant system and explores the results that these models are capable of producing With chapters authored by experts with years of research and teaching experience the Handbook of Processes and Modeling in the Soil Plant System examines physical chemical and biological soil processes the soil formation and weathering process and its modeling the impact of radioactive fallout on the soil plant system soil degradation processes and ways to control them water and matter dynamics in the soil plant system growth and development of crops at various levels of production the potentials and limitations of using simulation models Students educators and professionals alike will find the Handbook of Processes and Modeling in the Soil Plant System an invaluable reference on the soil plant atmosphere system and an ideal tool to help develop an effective decision support system

Arbuscular Mycorrhizal Fungi as Plant Biostimulants for Sustainable Agriculture Arvind Kumar Rai, Priyanka Chandra, Nirmalendu Basak, Parul Sundha, Rajender Kumar Yadav, 2025-06-05 Global agriculture production systems are confronted with difficulties due to increased food demand rising hunger and malnutrition negative climate change effects and overuse of natural resources According to the FAO's definition of sustainable food and agriculture agricultural strategies should support technologies that increase output without having a negative impact on biodiversity or

natural resources while also boosting productivity A plant s biostimulants are natural products which stimulate a plant s nutrition and productivity through enhancing nutrient use efficiency tolerance to abiotic stress and quality traits The present book studies arbuscular mycorrhizal fungi AMF a plant biostimulant which forms symbiotic relations with plants having a significant impact on performance and nutrition particularly regarding plant mineral intake capacity AMF through several mechanisms in plants can boost immunity against biotic and abiotic stresses Exploitation of AMF to improve crop productivity will be the key for future sustainable agriculture *Modelling in Geography* Reginald William Thomas, Richard J. Huggett, 1980-01-01 To find more information about Rowman and Littlefield titles please visit www.rowmanlittlefield.com

Advances in crop modelling for a sustainable agriculture Emeritus Professor Ken Boote, 2019-12-03 Focus on development of next generation of whole farm models to improve decision making and support for farmers Addresses the challenges of combining modular sub systems into whole farm system models Reviews the performance of specific models such as APSIM and DSSAT **Global Ecodynamics**, 2004-07 Opening with a survey of contemporary global ecodynamics including its basic components this book goes on to discuss greenhouse effect problems in the context of global carbon cycle dynamics The coverage includes land ecosystem changes air sea exchange models high latitude environmental dynamics and a discussion of basic aspects of global environmental modelling and relevant monitoring systems The volume concludes by examining society systems with emphasis on the problems of sustainable development **Global Ecodynamics** Kirill Y. Kondratyev, Vladimir F. Krapivin, V. P. Savinykh, Costas A. Varotsos, 2012-12-06 During recent decades the stirring up of the processes of globalization practically in all spheres of present day civilization activities has aggravated and brought forth numerous problems resulting from the nature society N S interaction It has become apparent that to solve these problems it is necessary to develop new concepts and approaches to the interpretation of global environmental changes that would enable one to select the first priority directions in studies and to reliably assess the state of the nature society system NSS One of these priorities is to predict global climate change The growing interest in the problem of global climate change determined by its practical importance and by available contradictory estimates of the anthropogenic contribution to climate change necessitates a systematization of knowledge of and data on the observed climate change and causes of this change Despite an enormous amount of projects and programmes of studies of past and present climatic trends the problem of reliable prediction of future climate change remains far from being solved Emissions to the atmosphere of greenhouse gases GHGs mainly carbon dioxide is considered as one of the main causes of an expected climate warming resulting in sufficiently negative consequences for humankind Therefore an attempt has been made in this book to construct a formalized technology to assess the level of the greenhouse effect due to anthropogenic sources of carbon dioxide as well as the effects of other gas components *SOIL MICROBIOLOGY A MODEL OF DECOMPOSITION & NUTR CYCLING* O. L. Smith, 1982-05-11 A perspective of modeling A review of models in soil microbiology Mathematical development A decomposition and nutrient

cycling model Mathematical basis of the spatial approximation The decomposers The general microbe population The nitrifiers Symbols Parameters The carbon cycle Disintegration of dead plant and animal matter Free polysaccharide in soil Bound polysaccharide Simple sugar in soil solution The phosphorus cycle Free organic phosphorus in soil Bound phosphorus Mineral phosphorus Soil solution phosphorus The potassium cycle Potassium leached from live cells Potassium leached or dissolved from dead cells Nonexchangeable potassium Exchangeable potassium Soluble mineral potassium Atmospheric input and groundwater loss Soil solution potassium The nitrogen aromatic cycle Free organic nitrogen in soil Bound organic nitrogen Condensable aromatics Soil solution NH_4 Soil solution NO_2 and NO_3 Cell chemistry Plants Microbes Temperature and moisture dependence of processes Organic and inorganic reactions The role of plants in decomposition and nutrient cycling Model development Comparison of model with experiment Comparison of model with theories of plant growth Simplified version of the plant model The steady state Phosphorus Potassium Nitrogen The dynamic state Overall pattern of decomposition and microbe growth The influence of substrate carbon and nitrogen content on mineralization and immobilization Microbe growth limited by nitrogen Wastage of substrate The rate limiting step of nitrogen mineralization The priming effect of soil amendments on rate of mineralization Accumulation of organic matter in soils Effect on microbes of oscillating low soil temperatures Effect on microbes of soil moist dry cycles Microbe and plant competition for nutrients Strategy of optimum crop fertilization A look ahead Mathematical and numerical techniques The Runge Kutta method Solution of coupled nonlinear algebraic equations

Plant Growth Modeling RES Mgmt Karen Wisiol, 1987-11-30 Part I Current plant growth models applications and data Mathematical descriptions of plant growth and development Applied plant growth models for grazinglands forests and crops Data for plant growth modeling and evaluation Parte II Forecasting and estimating plant yield Choosing a basis for yield forecasts and estimates Forecasting and estimating effects of weather on yield The scale problem modeling plant yield over time and space Part III The future of applied plant growth modeling The future of applied plant growth modeling

Grassland Dynamics J. H. M. Thornley, 1998 The development of computer simulation models is an important growth area in both pure and applied ecology The opportunity that mathematical models provide to integrate the components of an ecosystem results in the ability to make quantitative predictions about the future behavior of that system or of elements within it This means that they are powerful tools with wide applications and enormous potential for increasing our understanding of natural systems and our ability to use them in a sustainable way This book is almost uniquely a complete account of one such model the Hurley Pasture Model a dynamic deterministic mechanistic simulation model for grassland which has been developed by the author over some 20 years in collaboration with scientists at several centers Firstly the rationale and theoretical elements of this type of model are described An overview of the Hurley grassland simulator and the derivation and construction of its plant animal soil and litter water and environment and management components is then given Next the model is evaluated by a series of long and short term dynamic simulations

and steady state responses which demonstrate how predictions can be made about the effects of for example climate change or particular regimes of fertilizer application grazing or cutting This book will be of great value to grassland agronomists and modellers crop physiologists and plant ecologists and to students of ecology as a case study of a plant ecosystem model It will also be of interest to other ecologists and environmentalists and those in the field of computer modelling and its applications

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Dissertation Abstracts International ,2008 *Effects of Global Change on a California Annual Grassland* Lisa A.

Moore,2005 Dynamics of Nutrient Cycling and Food Webs Donald Lee DeAngelis,1992 Discusses aspects of nutrient cycling and food webs covering such areas as nutrients and autotrophs autotroph herbivore interactions disturbances to nutrient limited food webs effects of spatial extent and implications for global change Soils and Fertilizers ,1998

Farm Management in Mixed Crop-livestock Systems in the Northern Highlands of Ethiopia Assefa Abegaz,2005

Ecology, Conservation, and Management of Kwar Lake U. P. Sharma,1995 *New Zealand Journal of Crop and Horticultural Science* ,1989 Selected Water Resources Abstracts ,1972

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Table of Contents Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant

1. Understanding the eBook Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - The Rise of Digital Reading Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Advantages of eBooks Over Traditional Books
2. Identifying Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - User-Friendly Interface
4. Exploring eBook Recommendations from Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant

- Personalized Recommendations
- Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant User Reviews and Ratings
- Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant and Bestseller Lists
- 5. Accessing Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant Free and Paid eBooks
 - Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant Public Domain eBooks
 - Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant eBook Subscription Services
 - Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant Budget-Friendly Options
- 6. Navigating Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant eBook Formats
 - ePub, PDF, MOBI, and More
 - Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant Compatibility with Devices
 - Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Highlighting and Note-Taking Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Interactive Elements Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
- 8. Staying Engaged with Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
- 9. Balancing eBooks and Physical Books Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Setting Reading Goals Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant

- Fact-Checking eBook Content of Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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