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Editors

Emerging Nanotechnologies for Agroecosystem Management

Springer

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ISSN 3004-8273 ISSN 3004-8281 (electronic)
Smart Nanomaterials Technology
ISBN 978-981-95-0186-1 ISBN 978-981-95-0187-8 (eBook)
https://doi.org/10.1007/978-981-95-0187-8

Preface

Global food production faces several challenges, including climate change, population growth, resource scarcity, pollution, and economic instability. As the world moves toward 2050, innovative solutions are key to securing a stable and sustainable food future. Nanotechnology can potentially enhance agricultural inputs' efficiency and significantly boost food productivity. The delivery mechanisms of nanoparticles have attracted attention from across the world. Our book has emphasized the transformative potential of nanotechnology by highlighting its recent applications.

Nanomaterials enhance soil fertility, stimulate plant growth, provide crop protection, facilitate environmental remediation, and improve crop productivity. The synthesis of nanoparticles using green synthesis methods offers an eco-friendly approach that minimizes toxic byproducts and utilizes renewable resources. Nanofertilizers enhance nutrient absorption in plants and enable site-specific nutrient delivery. Nanomaterials play a crucial role in water remediation, enhancing irrigation management by improving water quality and availability for agricultural use. Nanosensors are emerging as a real-time monitoring tool in agriculture for detecting biotic and abiotic stresses. The chapter on regulatory aspects and risk assessment of nanoplatforms for agricultural uses focuses on the safe application of nanotechnology in enhancing crop production while protecting consumer health and the environment.

This book represents a significant contribution to the field, drawing insights and perspectives from diverse contributors across various regions of the globe. We extend our heartfelt gratitude to all contributors for their invaluable input and support. The compilation will provide valuable insights for students (undergraduate and postgraduate), experts, stakeholders, policymakers, and other enthusiastic readers.

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Nanofertilizers for Plant Nutrition

P. Smriti Rao, Faria Fatima, Abdul Mazeed, Munny Chinyo, and Khalid Habib

Abstract In a startling saga of agricultural overabundance, the once-fertile soil has suffered greatly from the pervasive use of synthetic fertilizers in contemporary agricultural practices, which has severely depleted its essential nutrients and irreversibly damaged the vital equilibrium of the surrounding environment. Overuse of these fertilizers degrades soil quality, pollutes the environment, disturbs agrarian ecosystems, and deposits residue on agricultural products. Moreover, between 50 and 70% of the nutrients including potassium, phosphate, and nitrogen are lost from the soil before they can be used. Nanoparticles regulate nutrient delivery, making nanofertilizers more economical and efficient than conventional fertilizers. A new class of fertilizers called nanofertilizers makes use of cutting-edge nanotechnology to offer a potent and eco-friendly approach to crop fertilization. They ensure that nutrients are distributed uniformly over an extended period of time with their regulated nutrient delivery system, providing plants that provide a consistent flow of vital components. Because it requires less fertilizer and less frequent management, the regulated discharge technology works better than standard fertilizers. In agriculture, nanotechnology is primarily utilized to enhance crop yields, reduce losses, and stimulate plants to defend against pests, insects, and environmental challenges. Nanofertilizers have shown promising results in various plant species, whether applied topically or in the soil. Most nanomaterials are precursors of macro- and micronutrients and their nanoscale properties. This chapter explores new approaches to using them as crop growth promoters, as well as how to apply and incorporate them into plant matter. It also discusses future concerns and possible drawbacks for the commercial implementation of nanofertilizers in agriculture.

Keywords Nanofertilizers · Nutrient use efficiency · Slow-release formulations · Soil fertility · Sustainable agriculture

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L. F. Fraceto et al. (eds.), *Emerging Nanotechnologies for Agroecosystem Management*, Smart Nanomaterials Technology, https://doi.org/10.1007/978-981-95-0187-8_4