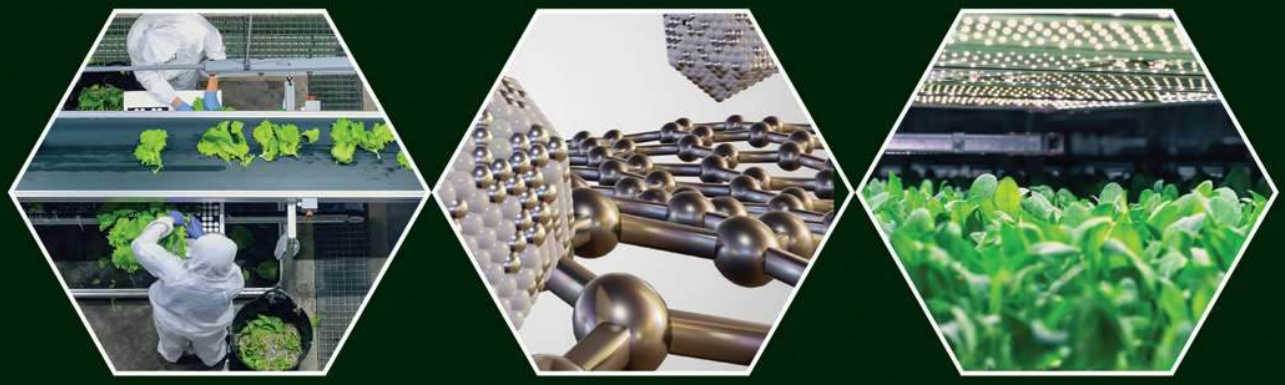
NANOMATERIAL-PLANT INTERACTIONS

Nanomaterials for Enhanced Plant-Based Food Production



Edited by
Huseyin Tombuloglu
Guzin Tombuloglu
Khalid Rehman Hakeem
Faheem Shehzad Baloch
Mohammad Azam Ansari

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Edited by

Huseyin Tombuloglu
Department of Genetics Research, Institute for Research and Medical Consultations (IRMC), Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Guzin Tombuloglu
Independent Researcher, Khobar, Saudi Arabia

Khalid Rehman Hakeem
Department of Biological Sciences, King Abdulaziz University, Jeddah, Saudi Arabia; Princess Dr Najla Bint Saud Al- Saud Center for Excellence Research in Biotechnology, King Abdulaziz University, Jeddah, Saudi Arabia; Department of Public Health, Daffodil International University, Dhaka, Bangladesh; Research and Innovation Cell, Rayat Bahra University, Mohali, Punjab, India

Faheem Shehzad Baloch
Department of Biotechnology, Faculty of Science, Mersin University, Mersin, Turkiye; Department of Plant Resources and Environment, Jeju National University, Republic of Korea

Mohammad Azam Ansari
Department of Epidemic Diseases Research, Institute for Research and Medical Consultations (IRMC), Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

Series Editors

Vijay Pratap Singh

Durgesh Kumar Tripathi

Jose Peralta-Videa

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List of contributors

Ali Abbas Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Muhammad Abdullah Institute of Environmental Sciences and Engineering (IESE), School of Civil and Environmental Engineering (SCEE), National University of Sciences and Technology (NUST), Islamabad, Pakistan

Asad Ahmad Department of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India

Ijaz Ahmad Department of Agronomy, Engro Fertilizers Ltd., Lahore, Punjab, Pakistan

Usama Ahmad Department of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India

Ambareen Fatima Ahmed School of Pharmaceutical Sciences, Integral University, Lucknow, Uttar Pradesh, India

Tayyaba Akhtar Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Muhammad Asif Ali Department of Agronomy, Engro Fertilizers Ltd., Lahore, Punjab, Pakistan

Muhammad Tanveer Altaf Department of Field Crops, Faculty of Agriculture, Recep Tayyip Erdoğan University, Rize/Pazar, Türkiye

Anshu All India Institute of Medical Sciences, New Delhi, India

Asif Mahmood Arif Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan; Institute of Plant Protection, MNS University of Agriculture, Multan, Pakistan

Muhammad Nadeem Ashraf Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Md Abdullah Al Asif Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

Muhammad Mahran Aslam Nuclear Institute of Agriculture (NIA), Tandojam, Hyderabad, Sindh, Pakistan

Muhammad Atiq Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan

Ebru Batı Ay Department of Plant and Animal Production, Suluova Vocational School, Amasya University, Amasya, Türkiye

Faheem Shehzad Baloch Department of Biotechnology, Faculty of Science, Mersin University, Mersin, Turkiye; Department of Plant Resources and Environment, Jeju National University, Republic of Korea

Madhumita Barooah Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat, Assam, India; DBT-North East Centre for Agricultural Biotechnology (DBT-NECAB), Assam Agricultural University, Jorhat, Assam, India

Muzaffer Barut Department of Field Crops, Faculty of Agriculture, Çukurova University, Adana, Türkiye

Muhammad Amjad Bashir Department of Agronomy, Engro Fertilizers Ltd., Lahore, Punjab, Pakistan

Pourya Bazyar Department of Mechanical Engineering and Production Management, Hamburg University of Applied Science, Hamburg, Germany

Amarjeet Singh Bhogal Department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat, Assam, India

Sudipta Sankar Bora DBT-North East Centre for Agricultural Biotechnology (DBT-NECAB), Assam Agricultural University, Jorhat, Assam, India

Mahmut Camlica Department of Field Crops, Faculty of Agriculture, Bolu Abant Izzet Baysal University, Bolu, Türkiye

Ishani Chakrabartty Learning and Development Solutions, Medical Affairs, Indegene Pvt. Ltd., Bengaluru, Karnataka, India

Mudharima Chaudhuri Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Sayequa Shujauddin Dandoti Food and Drug Research Department, Rating Intelligence, Bangalore, Karnataka, India

Jugabrata Das College of Horticulture and Farming System Research, Assam Agricultural University, Nalbari, Assam, India

Siddhartha Das Department of Plant Pathology, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Priyadarshini Deka Hereditary Biosciences, Guwahati, Assam, India

Zia Ur Rahman Farooqi Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Fathima Feroz Department of Food Technology and Nutrition, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Iqra Ghafoor Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Ipsita Ghosh Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India

Rahul Gogoi Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat, Assam, India

Yashodhara Goswami School of Bio-Sciences & Technology, M.Sc. Biomedical Genetics, Vellore Institute of Technology, Vellore Campus, Katpadi, Tamil Nadu, India; Department of Biomedical Genetics, School of Biosciences and Technology, Vellore Institute of Technology, Vellore Campus, Vellore, Tamil Nadu, India

Humira Gulzar Division of Plant Pathology, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadoora, Jammu and Kashmir, India

Muhammad Itazaz Hassan Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

S. Manjura Hoque Department of Materials Science, Atomic Energy Centre, Dhaka, Bangladesh

Musawar Hussain Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan

Noshin Ilyas Department of Botany, PMAS Arid Agriculture University, Rawalpindi, Punjab, Pakistan

Anas Islam Faculty of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India

Sudipta Jana Department of Plant Pathology, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India

Koyel Kar Department of Pharmaceutical Chemistry, BCDA College of Pharmacy & Technology, Hridaypur, Kolkata, West Bengal, India

Mohd Muazzam Khan Department of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India

Priyobarta Singh Khumukcham Department of Soil Science, Assam Agricultural University, Jorhat, Assam, India

Lyubka Koleva Department of Plant Physiology, Biochemistry, and Genetics, Agricultural University, Plovdiv, Plovdiv, Bulgaria

Muhittin Kulak Department of Herbal and Animal Production, Vocational School of Technical Sciences, Igdir University, Igdir, Türkiye

Sanjeev Kumar Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India; Department of Fruit Science, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Waqas Liaqat Department of Field Crops, Faculty of Agriculture, Çukurova University, Adana, Türkiye

Farah Mahjabin School of Science, Western Sydney University, Richmond, NSW, Australia

Subaya Manzoor Division of Plant Pathology, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadoora, Jammu and Kashmir, India

Mehdi Maqbool Department of Horticulture, University of Poonch Rawalakot, Kashmir, Pakistan

Mahrukh Mehraj Department of Food Technology and Nutrition, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Anis A. Mirza Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Muhammad Azhar Nadeem Faculty of Agricultural Sciences and Technologies, Sivas University of Science and Technology, Sivas, Türkiye

Muhammad Shahbaz Naeem Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Sedef Ozliman Department of Plant and Animal Production, Vocational School of Ataturk Health Services, Afyonkarahisar Health Sciences University, Afyonkarahisar, Türkiye

Deepu Pandita Government Department of School Education, Jammu, Jammu and Kashmir, India

Kaushik Pramanik Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India

Nasir Ahmed Rajput Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan

Hafiz Muhammad Ali Raza Department of Soil Science, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Punjab, Pakistan; Department of Soil Science, College of Agriculture, University of Layyah, Layyah, Punjab, Pakistan

Qurat-Ul-Ain Raza Department of Soil Science, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Punjab, Pakistan

Abdur Rehim Department of Soil Science, Faculty of Agricultural Sciences and Technology, Bahauddin Zakariya University, Multan, Punjab, Pakistan

Zarrin Fatima Rizvi Department of Botany, Government College Women University, Sialkot, Punjab, Pakistan

Maimona Saeed Department of Botany, Government College Women University, Sialkot, Punjab, Pakistan

Akif Safeen Department of Physics, University of Poonch Rawalakot, Kashmir, Pakistan

Kashif Safeen Department of Physics, Abdul Wali Khan University Mardan, Mardan, Pakistan

Nancy Saini Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Saman Sarfraz Department of Botany, Government College Women University, Sialkot, Punjab, Pakistan

Subhajit Sen DBT-North East Centre for Agricultural Biotechnology (DBT-NECAB), Assam Agricultural University, Jorhat, Assam, India

Mohsin Shad School of Biological Sciences, University of the Punjab, Lahore, Punjab, Pakistan

Aqila Shaheen Department of Soil and Environmental Sciences, University of Poonch Rawalakot, Azad Jammu and Kashmir, Pakistan

Jyoti Bharati Sharma Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Ehsan Sheidaee Biosystems Engineering Department, Tarbiat Modares University, Tehran, Iran

Yaqoob Sultan Department of Grass Breeding, Institute of Agriculture, Lithuanian Research Centre for Agriculture and Forestry, Kėdainiai, Lithuania

Antoni Szumny Department of Food Chemistry and Biocatalysis, Wrocław University of Environmental and Life Sciences, Norwida 25, Wrocław, Poland

Leyla Sezen Tansi Department of Field Crops, Faculty of Agriculture, Çukurova University, Adana, Türkiye

Yasira Tariq University of Management and Technology, Lahore, Punjab, Pakistan

Muhammad Danish Toor Department of Soil Science & Plant Nutrition, Faculty of Agriculture, Ondokuz Mayis University, Samsun, Turkey

Izhar Ullah Department of Horticulture, Faculty of Agriculture, Ondokuz Mayis University, Samsun, Turkey

Muhammad Usman Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan

Ab Waheed Wani Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Gulsum Yaldiz Department of Field Crops, Faculty of Agriculture, Bolu Abant Izzet Baysal University, Bolu, Türkiye

Noosheen Zahid Department of Horticulture, University of Poonch Rawalakot, Kashmir, Pakistan

Zarina Division of Vegetable Science, Faculty of Horticulture & Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu), Chatha, Jammu, India

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Chapter 14

Nanodrug delivery in plants: why, when, and how?

Anas Islam[1], Ambareen Fatima Ahmed[2], Usama Ahmad[3], Asad Ahmad[3] and Mohd Muazzam Khan[3]
[1]*Faculty of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India,* [2]*School of Pharmaceutical Sciences, Integral University, Lucknow, Uttar Pradesh, India,* [3]*Department of Pharmacy, Integral University, Lucknow, Uttar Pradesh, India*

14.1 Introduction

Nanodrug delivery in plants is an innovative and cutting-edge approach that utilizes nanosized vesicles to effectively transport small molecular drugs to specific target tissues (Sarvarian et al., 2022). The integration of nanoscience with bioactive natural compounds has gained momentum, offering numerous advantages in the realm of delivering therapeutic natural products to combat cancer and various other diseases (Patra et al., 2018). The pursuit of the perfect nanoparticle for drug delivery hinges on a thorough understanding of the intricate physicochemical characteristics possessed by various drugs. The selection process examines the biophysical and biochemical properties inherent to these medications and the potential obstacles, such as toxicity, that nanoparticles may present in nanomedicine applications. As research progresses, new strategies are emerging that harness the power of combining natural products with nanoparticles to mitigate any associated toxicities (Patra et al., 2018). The utilization of nanoparticles in agriculture offers a fascinating approach to delivering vital nutrients directly to crops. In particular, there have been groundbreaking advances in employing nanoscale drug-delivery systems consisting of plant-derived lipids. These ingenious systems are ingeniously loaded with essential agricultural nutrients and delicately applied onto the leaves of tomato plants. What's remarkable is that these minute particles possess the extraordinary ability to penetrate through the leaf surface, effortlessly traversing within and across different leaves before ultimately reaching the roots for optimal distribution purposes (Karny et al., 2018).

Enhancing the production of plant-based foods is of significant importance due to a multitude of reasons. The emphasis on environmental sustainability, public health, economic development, and innovation are key driving forces behind this endeavor. Plant-based diets offer a promising solution for achieving greater ecological balance as compared to diets predominantly reliant on animal products. By utilizing fewer natural resources and contributing to lower greenhouse gas emissions, these diets play a vital role in ensuring long-term environmental stability (Alcorta et al., 2021). Expanding the production of plant-based foods offers a promising avenue to alleviate the detrimental effects of our food system on both the environment and biodiversity. While the potential benefits of plant-based foods for human health are well-documented, the primary objective of this chapter is to explore the application of nano drug delivery systems to enhance plant growth and productivity. This technology offers a promising avenue to improve agricultural efficiency and address global food security. By focusing on the innovative use of nanotechnology in plant science, we aim to provide insights into how nano drug delivery can optimize plant health and yield, ultimately contributing to a more sustainable and productive agricultural sector. This chapter will explore into the specific mechanisms and applications of nano drug delivery, examining its potential to revolutionize plant cultivation and resource management. This involves creating ingenious solutions that not only bridge the gap between current intake levels and higher recommended values, but also specifically cater to vegetarian and flexitarian consumers. By harnessing high-quality sources of vitamin D, these innovative plant-based foods can play an instrumental role in preventing or reversing deficiencies among these individuals. Additionally, as the food industry develops fortified alternatives and plant-based products, careful consideration should be given to both calcium inhibitors and enhancers. By incorporating this multidimensional approach into their strategies, companies can truly revolutionize the landscape of plant-based nutrition (Alcorta et al., 2021). Furthermore, the concept of home gardens has long been embraced and applied by local communities facing resource constraints and a lack of institutional assistance. These gardens offer great potential to improve food security and

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