



# RECENT ADVANCES AND APPROACHES FOR CROP IMPROVEMENT AND SUSTAINABLE AGRICULTURE

Dr. Swati Sharma | Dr. Amita Dubey



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FOR CROP IMPROVEMENT AND  
SUSTAINABLE AGRICULTURE**

*Editors:*

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## Chapter 1

# EXPLOITING SEED COATINGS FOR SUSTAINABLE AGRICULTURE: RECENT TRENDS AND ADVANCES

**Shefali Singh<sup>1</sup>, Ambreen Bano<sup>1</sup>, Smita Rai<sup>1</sup>, Anmol Gupta<sup>1</sup>, Richa Mishra<sup>2</sup>, Swati Sharma<sup>1\*</sup> and Neelam Pathak<sup>2\*</sup>**

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Seed treatment refers to the application of certain agents physical, chemical or biological to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack seeds. Plant growth promoting microorganisms (PGPM) are recognized as essential contributors to improving agricultural productivity via direct application to the rhizosphere and plant tissues, or seed inoculation. Seed coating with Plant beneficial microorganisms (PBMs) are a quick and effective tool to increase the seed germination rate and seedling stability, hence insuring the functioning of MAP life cycles. Biological seed treatments are expected to be one of the fastest growing seed treatment sectors in the near future, in part because they are easier to register at Environment Protection Agency (EPA). Physical and biological seed treatments alone an alternative to chemicals or in combination with a chemical treatment are being used



## Chapter 2

# **RHIZOBACTERIA MEDIATED ENHANCEMENT IN GROWTH AND PHYTOCHEMICALS OF MEDICINAL PLANTS: INOCULATION EFFECTS**

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Medicinal plants have traditionally been utilised for treatment numerous health diseases or used as food additives, and medicinal herbs have long been employed as a natural remedy. Secondary metabolites are becoming an important element of human health, with importance of plant extracts. The medicinal plants cultivation to provide bio-active substances has enhanced globally to meet the needs of the food, pharmaceutical, and health sectors. Chemical fertilisers used to maximise biomass and production have a negative influence on the phytoconstituents growth and development in medicinal plant. Because of its eco-friendly behaviour, low cost, and non-destructive nature on fertility of soil, human, and plants health, advantageous rhizosphere microbiota application is an alternative strategy for increasing the valuable medicinal plants production under both conventional and stressed conditions. The microbiological method increases plant development through a variety of direct and indirect

## Chapter 3

# A COMPREHENSIVE STUDY OF MICROBIAL ENDOPHYTES FOR ABIOTIC STRESS MANAGEMENT IN PLANTS: AN OVERVIEW

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Endophytes are the hidden treasure of plants living inside the host plant asymptotically. They have the ability to enhance the plant growth under adverse condition and protect the plant against pests and plant pathogen. There are various biotic and abiotic factors which directly or indirectly affect the agricultural crops productivity and hence results in significant loss in crops. Excessive use of chemical fertilizer and pesticides for increasing the crop productivity increases the environmental pollution and decreases the nutrient value of food. Hence Microorganism with plant growth promoting ability is necessary for improving the yield of agricultural crops and enhance the disease tolerance. A favourable host-microbe interaction may be used as a biofertilizer or bio-stimulant or biocontrol agent instead of pesticides to minimise the agrochemical input. Use of Bacteria and Fungi as a



## Chapter 4

# POKKAH BOENG DISEASE IN SUGARCANE: CAUSAL ORGANISM AND ITS MANAGEMENT

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Pokkah boeng disease on sugarcane was previously considered a minor disease in 1930s but in recent years its disastrous effect has made it a major and important disease. The pathogen *Fusarium* spp. complex is known to cause considerable damage to sugarcane. Its incidence has been observed in many recommended and good-yielding cane varieties. Co 317 has been reported to infect the disease with an incidence rate of 2.4-2.8% and S 224/20 with 90% incidence rate. The canes infected with this fungal disease attack the apical part thus causing damage to the growing point. The diseased plant is a deficit in trace elements and macro elements. Furthermore, sucrose in the juice was also reduced. Due to the rapid spreading and damaging scenario, it is important to understand and know more about this disease. The chapter highlights the insight of Pokkah boeng disease in sugarcane and its management strategies for better understanding of this disease.

**Keywords:** Sugarcane, Stalk, Knife Cut, Twisting, Disease

## Chapter 5

# POTENTIAL OF PHOSPHATE-SOLUBILIZING MICROORGANISMS IN AGRICULTURE

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One of the most critical components in plant growth and development is phosphorus (P). Chemical fertilisers, which are expensive and have a harmful influence on the environment, can be used to compensate for its lack. Their continued usage depletes soil fertility and causes the buildup of harmful substances, which affects the natural soil microflora, resulting in an equilibrium imbalance. Phosphate solubilizing microorganisms (PSM) might be a viable approach for overcoming P deficit without creating environmental impact. Their biodiversity, mode of action, colonization potential, and careful importance should all be considered as reliable components in long-term agricultural systems. The use of PSM as biofertilizers for sustainable agriculture has been covered in this chapter.

**Keywords:** Crops productivity, Phosphate solubilizing microbes, Solubilization, Nanotechnology, Sustainable agriculture

## Chapter 6

# **TRICHODERMA: A PANACEA FOR SUGARCANE SUSTAINABLE AGRICULTURE**

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*Trichoderma* species have been frequently documented to boost plant growth promotion and as a Biocontrol agent (BCA). The most typical manifestation of growth promotion is increased root and/or shoot biomass, although alterations in plant shape and development have also been recorded. Due to various limiting parameters, such as crop type, growing circumstances, inoculum rate, and formulation type, growth promotion can be very varied. Control of plant diseases, higher nutrient uptake, increased glucose metabolism and photosynthesis, and phytohormone production are some of the processes claimed to explain growth promotion. Microbe-produced indole acetic acid appears to play an important function. There is substantial evidence for the role of microbe-produced indole acetic acid (IAA). Although it is most probable that *Trichoderma* promotes growth through changing the balance of hormones such as IAA, gibberellic acid, and ethylene.

**Keywords:** competition, antibiosis, biocontrol, sugarcane

### **1. Introduction**

The sugarcane farmers facing a problem in increasing yields while reducing plant disease to a minimum. Traditional approaches for plant



## Chapter 7

# EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) ON PLANT GROWTH UNDER BIOTIC STRESS CONDITION

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Bacteria, viruses, nematodes, arachnids, and weeds all come into contact with the plants. These organisms cause biotic stress on their hosts by altering normal metabolism, which results in reduced plant development and plant death. Plant-associated microorganisms can control physiological and molecular responses to deal with pathogenic biotic stress via increased antioxidant defense mechanisms and alleviate oxidative stress as Arbuscular Mycorrhizal Fungi (AMF). Several bacteria can aid plant development and operate as a biofertilizer and biopesticide, comparable to pesticides and artificial fertilizers. Plant growth-promoting rhizobacteria (PGPR) can boost plant development and constitute a beneficial plant-microbe interaction by improving nutrient absorption in the environment. *Bacillus*,

## Chapter 8

# RNA INTERFERENCE: AN APPROACH FOR GENETIC MANIPULATION OF MEDICINAL PLANTS.

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Most of the drugs used in traditional systems of medicine are derived from medicinal plants. Plants synthesize these important compounds mostly as their secondary metabolites. Biosynthetic pathways of many secondary metabolite synthesizing pathways are yet to be explored. The regulation studies of bioactive phytochemicals have benefited immensely from RNA interference technology. For functional characterization of the genes involved in secondary metabolite biosynthesis pathways, RNA interference or Post Transcriptional Gene Silencing (PTGS) is an important tool. RNAi based approaches for functional characterization of the genes responsible for biosynthesis of some medicinally important compounds are discussed in the upcoming chapter.

**Keyword:** Dicer, silencing, siRNA, post transcriptional gene silencing (PTGS)

## Chapter 9

# CROP IMPROVEMENT FOR HETEROLOGOUS PROTEIN PRODUCTION

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The need to fulfill ever increasing demand of novel proteins for welfare of mankind has embarked an era of gene modification. The proteins that are not naturally expressed can be designed and produced in non-related species. The feat has been achieved by the application of recombinant DNA technology. This can be used to change the molecular levels of proteins expression. Such modified molecule may be expressed in prokaryotic as well as eukaryotic platforms with their own advantages and disadvantages. The plants have been explored for such heterologous expressions leading to development of new and improvement of existing varieties. The techniques using plant are still at laboratory level. Many optimizations at molecular level are required for commercial application. However, the plant expression systems have been extensively used for production of biopharmaceuticals.

**Keywords:** heterologous proteins, transgenic plants, vectors, gene fusion



## Chapter 10

# FUTURISTIC APPROACHES FOR SUSTAINABLE AGRICULTURE

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Sustainable agriculture is an environment/ecosystem friendly and economically viable approach for farming that lets us produce high yield, good quality crops and livestock without damaging the nature or ecosystem and its dynamics. Thus, sustainable agriculture is eco-agriculture encompassing both the ecosystem and economics under its umbrella. Sustainable agriculture facilitates preserving our nature and natural resources for our future generation without forcing us to compromise on fulfilling our needs and that of the society's. Thus, it helps us to operate our agriculture systems so as to sustain the ever-increasing population and their changing needs within a dynamic environment. Sustainable agriculture with a futuristic vision, will be multidimensional/ multipronged leading to integrated system is very much the need of the hour for Indian agriculture system. Sustainable agriculture has got a boost through Government initiatives, awareness among farmers, and digital technology.

**Keywords:** sustainable, agriculture, agri-innovation, digital, environment