Preface

Plant biotechnology is a scientific technique that adapts plants for specific purposes by cross-breeding, extending their growing seasons, adjusting height, colour and texture and several other mechanisms. Some plant biotechnologies exist for the purpose of creating reliable and sustainable food sources for populations around the world, while other technologies use plants for scientific and medical research and find ways to make crops resistant to droughts, diseases and other maladies. One type of plant biotechnology is transgenic biotechnology, which essentially involves exchanging plant genes to create a superior hybrid species. This type of biotechnology involves growing tissue cultures to develop unique new plants. The new species then exhibit the desired new trait, such as increased nutritional value or improved resistance to pests. Plant biotechnology is also used to create novel genetic combinations, such as hybridisation, mutation and transgenic movement. Hybridisation involves merging two distinct set of genes to create random combinations while mutation creates unpredictable changes to produce a series of random genes in just one plant. Transgenic gene movement involves inserting one or two new genes to an existing plant, which creates subtle changes. Some plant biotechnologies produce small changes to enhance certain plant qualities or characteristics while others produce entirely new specimens with altered physical characteristics.

This book summarises various aspects of Plant Biotechnology and is divided into 27 chapters.

Chapter 1 deals with plant biotechnology: A review. Chapter 2 is devoted to plant cell culture and development. Plant cell culture is the basis of many different technologies that are now proving to be of great benefit to many disciplines. The ability to culture plant cells or tissues is essential to the success of all of these techniques. Chapter 3 focuses on plant tissue culture. Tissue culture is the *in vitro* aseptic culture of cells, tissues, organs or whole plant under controlled nutritional and environmental conditions often to produce the clones of plants. The resultant clones are true-to type of the selected genotype. The controlled conditions provide the culture an environment conducive for their growth and multiplication. Chapter 4 concentrates on micropropagation. Micropropagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using modern plant tissue culture methods.

Chapter 5 focuses on germplasm storage. The sum total of all the genes and their alleles present in a crop and its related species constitutes its germplasm. It is ordinarily represented by a collection of various strains and related species of the concerned crop species. Chapter 6 deals with haploid plants. Haploid describes a cell that contains a single set of chromosomes. Haploid plants develop from anther culture either directly or indirectly through a callus phase. Chapter 7 concentrates on triploid plants. Triploid plants have larger organs, greater biomass and strong stress resistance by preserving relatively larger amounts of photosynthetic energy. Triploid plants have great economic value and have been useful for developing new agronomic, horticultural and forestry plant varieties.

Chapter 8 focuses on *in vitro* pollination and fertilisation. Pollination is the transfer of pollen, from the stamens to the stigma. The pollen is often carried by insects and other animals, but sometimes by wind or water. Fertilisation is the process of fusion of the female gamete, the ovum or egg and the male gamete produced in the pollen tube by the pollen grain. Chapter 9 deals with Protoplast isolation and culture. Plant protoplasts provides a unique single cell system to underpin several aspects of modern biotechnology. Isolation of protoplast is readily achieved by treating cells tissues with suitable mixture of cell wall degrading enzymes.

Chapter 10 concentrates on somatic cell hybridisation. Somatic hybridisation is a technique which allows the manipulation of cellular genomes by protoplast fusion. Its major contribution to plant breeding is in overcoming common crossing barriers among plant species and in organelle genetics and breeding. Chapter 11 focuses on synthetic seeds. Synthetic seeds are defined as artificially encapsulated somatic embryos, shoot buds, cell aggregates, or any other tissue that can be used for sowing as a seed and that possess the ability to convert into a plant under *in vitro* or *ex vitro* conditions and that retain this potential also after storage. Chapter 12 is devoted to plant breeding. Plant breeding involves the systematic production of crop populations exhibiting genetic segregation and selection within that population to establish lines with favourable allele combinations. Chapter 13 deals with plant derived vaccines. Plants offer enormous potential as production platforms for vaccines and therapeutic proteins. Plant-derived vaccines, for example, present an alternative to conventional vaccines by facilitating safe and effective oral delivery through consumption of edible plant tissue. Chapter 14 focuses on genetically modified foods. Genetically modified foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Chapter 15 concentrates on improving photosynthesis and crop yield. Photosynthesis is the process by which organisms use energy

from sunlight to convert carbon dioxide (CO_2) into carbohydrates, such as sugar (glucose). Crop plants grow almost entirely by photosynthesis. Thus, plant productivity in terms of primary production of biomass is simply a measure of the total photosynthesis of the plants less respiration, which has occurred during its growth. Chapter 16 focuses on insect resistant plants. Pest resistant GM crops (primarily cotton and maize), have been genetically modified so they are toxic to certain insects.

Chapter 17 is devoted to fungus resistant plants. The chapter discusses various preventive methods which can reduce fungus. Chapter 18 deals with virus resistance plants. Many genes derived from plant RNA viruses expressed in transgenic plants confer resistance against infection by viruses that were the original source of the genes and in some cases, by other viruses as well. Chapter 19 is devoted to plant biotechnology in ornamental plant. Ornamentals are all those plants which are cultivated with the main aim of being marketed and used for decorative purposes. Ornamental plants are grown for decoration, rather than food or raw materials. Chapter 20 concentrates on modification of flower colour using genetic engineering. The flower colour modification using molecular methods has now become reality. To date, the most successful applications have been in suppressing flavonoid biosynthesis at certain steps of the pathway, either by using the antisense or sense approach. Chapter 21 focuses on biotechnology in production of medicinal plants. Medicinal plants are the most important source of life saving drugs for the majority of the world's population. Biotechnological tools are important for multiplication and genetic enhancement of the medicinal plants by adopting techniques such as *in vitro* regeneration and genetic transformations.

Chapter 22 is devoted to recombinant DNA. DNA plant technology was an early pioneer in applying transgenic biotechnology to problems in agriculture. Chapter 23 is concentrates on molecular markers in plant biotechnology. A molecular marker is a molecule contained within a sample taken from an organism (biological markers) or other matter. It can be used to reveal certain characteristics about the respective source. DNA, for example, is a molecular marker containing information about genetic disorders, genealogy and the evolutionary history of life. Specific regions of the DNA (genetic markers) are used to diagnose the autosomal recessive genetic disorder cystic fibrosis. Chapter 24 focuses on plant biotechnology and climate change. Biotechnology can contribute positively by mitigating the impact of climate change through green house gas reduction, crops adaptation and increase in yield using less land. Chapter 25 concentrates on nanotechnology for micronutrients in soil-plant systems. New advances in nanotechnology can be a major factor shaping modern agriculture. Nanobiotechnologies occupy a prominent position in transforming agricultural systems and food production worldwide.

Chapter 26 focuses on nanotechnology in plants. Nanotechnology opens a large scope of novel application in the fields of biotechnology and agricultural industries, because nanoparticles (NPs) have unique physico-chemical properties, i.e., high surface area, high reactivity, tunable pore size and particle morphology. Nanoparticles can serve as 'magic bullets', containing herbicides, nano-pesticide fertilisers, or genes, which target specific cellular organelles in plant to release their content. Chapter 27 is devoted to intellectual property rights. Intellectual property rights can be defined as a set of laws devised for the purpose of protecting or rewarding inventors or creators of new knowledge. Intellectual property rights are intended to confer exclusive rights for inventors or discoverers, for a fixed period of time.

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It may not be wrong to hold that this book on *Plant biotechnology* is essential reading for professionals and students pursuing engineering courses in life sciences. Besides students, this book will prove useful to industrialists and consultants in the respective fields.

It has been prepared with meticulous care, aiming at making the book error-free. Constructive suggestions are always welcome from users of this book.

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