Plant Propagation by Tissue Culture
3rd Edition

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Volume 1. The Background

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Springer

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 978-1-4020-5004-6 (HB)
ISBN 978-1-4020-5005-3 (e-book)

Published by Springer,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

www.springer.com

Printed on acid-free paper

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Preface

It is now more than twenty years since the first edition of this work appeared and nearly fifteen since the second. Whilst much of the information in those editions has stood the test of time, inevitably, because of the pace of research, a new edition is clearly timely.

This is true, not only because many more species have been the subject of propagation studies, but because the background to the field – with which this volume deals – has changed almost out of all recognition. In particular, our knowledge of plant development, genetics physiology, biochemistry and molecular biology has expanded exponentially – often through work on mutants of *Arabidopsis* – and opened up many new avenues for the plant propagator to explore. Equally, the commercial significance of plant propagation has increased significantly. As an example, in the second edition there was a single chapter on plant growth regulators – in this there are three, reflecting the fact that not only is there more information on those PGRs we recognised in 1993, but that several new ones are now known. Equally, fifteen years ago we knew little of the molecular basis of plant development e.g. flower and shoot development, in this edition it has merited a whole chapter, much of which relates to discoveries in the last decade.

Because of these factors, it was felt that a different approach was required for this edition. The second edition was researched and written by Edwin George alone but it would now be very difficult for a single author to gain the breadth of expertise necessary to cover all the relevant aspects of this many-faceted subject. Hence, it was decided to adopt a multi-author approach, with chapters written by experts in their fields. These build upon the sound framework of the previous editions (which those with a knowledge of the previous works will recognise). Many sections of the previous work have been retained, but inevitably, apart from up-to-date reference lists, the text has undergone major revision in many areas.

Like the previous edition, the current one will appear in two volumes, but coverage has been extended and the order in which subjects are covered has been changed. Therefore, some topics, previously covered in Part 1, will now be discussed in Part 2. The ethos of the work is, as before, to produce an encyclopaedic text.

The first initiative to begin the new revision of *Plant Propagation by Tissue Culture* was made by Prof. A.C. Cassells and the editors are grateful to him for his early leadership. No work of this size can be accomplished successfully without much goodwill and hard work by the contributors, and to them the editors express their deepest thanks. We also express our sincere thanks to all those who have allowed us to use their material in diagrams and illustrations. We are very appreciative of the hard work by Dr. Susan Rafferty-McArdle of University College Cork in formatting the text, and to Dr. Jacco Flipsen of Springer for his support.

Edwin George
Mike Hall
Geert-Jan de Klerk
May 2007

Biographical Notes on Contributors

Chapter 1.

Edwin. F. George trained as a botanist at Imperial College, London and subsequently gained a PhD, working on breeding and selection of sugar cane at the Mauritius Sugar Industry Research Institute. He was later employed by ICI Ltd. and Plant Protection Ltd. to study plant growth regulating compounds and subjects for corporate research. He finally became an independent consultant and researched extensively into plant genetic engineering and especially plant tissue culture. This resulted in the books *Plant Culture Media, Vols. 1 and 2* (1987), and *Plant Propagation by Tissue Culture*. The latter work was first published in 1984 and then extensively revised and extended to two volumes in 1993 and 1996. The present book is based on the first volume of the 2nd edition of *Plant Propagation by Tissue Culture.* Dr. George prepared the diagrams for the current revision although he is now retired.

Chapter 2.

Pierre C Debergh is Emeritus-Professor of the University of Gent (Belgium) since 2004 and specialised in micropropagation since 1968. His major interest is in tissue culture (*sensu largo*) and horticulture applied to western and developing countries (Asia, Africa and the Carribean). He is editor of *Plant Cell Reports*; *Plant Cell, Tissue and Organ Culture* and the *South African Journal of Botany*. He is author of approx. 100 publications and supervisor of 35 PhD dissertations and more than 250 MSc dissertations.

Chapter 3.

Geert-Jan de Klerk is senior scientist in plant tissue culture since 1986, first in *The Centre for Plant Tissue Culture Research* in Lisse (Netherlands) and now in *Plant Research International, Wageningen University* (Netherlands). His main research interests concern plant developmental biology. He is editor-in-chief of *Plant Cell Tissue and Organ Culture* and editor of *Propagation of Ornamental Plants.*

Chapter 4.

Trevor A Thorpe was a PhD student of Toshio Murashige at the University of California, Riverside (USA). He was a Faculty Professor and now Professor Emeritus in the Department of Biological Sciences at the University of Calgary, Alberta, Canada. He retired in 1997 but is still an active researcher. His areas of interest include developmental plant physiology, experimental plant morphogenesis and micropropagation, mainly of woody plants. He was a former Chairman of the International Association for Plant Tissue Culture and former editor-in-chief of *In Vitro Cellular and Developmental Biology – Plant*.

Edward C Yeung was a PhD student of I Sussex at Yale University. He is an Assistant Professor in the Department of Plant Science at the University of Manitoba (Canada). His research interests are structural, physiological and biochemical ontogeny of plant embryogenesis and floral biology of orchids

Claudio Stassolla was a PhD student of Edward Yeung at the University of Manitoba, (Canada). His research is on plant somatic embryogenesis *in vitro*.

Andy V Roberts is Emeritus Professor in the School of Health and Biosciences at the University of East London (UK). His research interests are the use of *in vitro* methods for the propagation and genetic improvement of woody plants, particularly roses.

*Geert-Jan de Kler*k (see chapter 3)

Chapter 5.

Ivana Machackova is a Professor at the Institute of Experimental Botany of the Academy of Sciences of the Czech Republic in Prague (Czech Republic). She is Head of the Laboratory of Plant Morphogenesis and Director of the Institute. She lectures in the Department of Plant Physiology at the Charles University in Prgaue. Her research interests are in the area of plant growth substances (auxins, ethylene, abscisic acid and melatonin); their modes of action and metabolism, regulation of their levels in relation to plant development and electrophysiology.

Eva Zazimalova is an Associate Professor of Plant Physiology at the Institute of Experimental Botany of the Academy of Sciences of the Czech Republic in Prague. She is Head of the Laboratory of Hormonal Regulation in Plants and Deputy Director of the Institute. She also teaches in the Department of Plant Physiology at the Charles University in Prague. Her research is in the fields of auxin and cytokinins (mode of action of auxin, auxin binding site(s), regulation of levels of auxins and cytokinins in relation to cell division and elongation and the mechanism of polar transport of auxin).

Chapter 6.

Johannes van Staden was awarded his PhD (Botany) in 1970 and lectured in this field until 2003. He is a Professor and Director of the Research Institute for Plant Growth and Development, School of Biological and Conservation Sciences, University of KwaZulu-Natal (South Africa). His main interests are in the hormonal regulation of plant growth, seed germination, plant tissue culture and ethnobotany/medicine.

Eva Zazimalova (see chapter 5).

Chapter 7.

Igor E Moshkov is a Leading Researcher in plant physiology and biochemistry and Deputy Director at the Timiryazev Institute of Plant Physiology, Russian Academy of Science, Moscow. His research is focussed on ethylene signal perception and transduction, the interaction between ethylene and cytokinin at the level of hormone perception and signal transduction pathways and GTP-binding proteins in phytohormone signalling.

Galina V Novikova is a Leading Researcher in plant physiology and biochemistry at the Timiryazev Institute of Plant Physiology, Russian Academy of Science, Moscow. Her research is related to the mode of action of phytohormone action (cytokinins and ethylene) and interactions of the phytohormones, protein phosphorylation/dephosphorylation in relation to phytohormone signal perception and transduction and MAPK cascades in phytohormone signal transduction.

Michael A Hall has been Professor of Botany at the University of Wales, Aberystwyth (UK) since 1981. His research is involved with signal perception and transduction mechanisms for plant hormones, especially ethylene, as well as the role of hormones in the responses of plants to environmental stress.

Chapter 8.

Dominique Chriqui is Professor and Director of a laboratory of plant development at the University Pierre and Marie Curie, Paris (France). She has been involved for many years in research on the cellular and molecular features that underlie morphogenic events such as rhizogenesis and shoot regeneration, both in planta and *in vitro*. She is now particularly interested in the early events of the regenerative process and in the interfaces between hormones, cell cycle and developmental genes and has published approx. 100 papers in the field of plant morphogenesis.

Chapter 9.

Sara von Arnold holds a PhD from Uppsala University (1979), Sweden. She has been a full Professor in the Cell Biology of forest trees at the Swedish University of Agricultural Sciences, Uppsala since 1988. Her research focusses on developmental processes in conifers and especially somatic embryogenesis.

Chapter 10.

Peter B Gahan is Emeritus Professor of Cell Biology at King's College London (UK) with fifty years of research and teaching experience in plant and animal biology. He is interested in the mechanism of competence and recalcitrance of plant cells to regenerate and also in the role of DNA as a messenger between cells and tissues.

Chapter 11.

John Preece is a horticulture professor in the Department of Plant, Soil and Agricultural Systems at Southern Illinois University Carbondale (USA). He teaches courses in General Horticulture, Plant Propagation and Plant Growth and Development. He conducts research on various aspects of woody plant propagation. Along with his postgraduates, he was the first to publish micropropagation protocols for a number of woody species and the first to work out somatic embryogenesis and shoot morphogenesis of *Fraxinus americana* (white ash) and *Juglans nigra* (eastern black walnut).

Chapter 12.

William (Bill) Davies is currently Professor of Environmental Plant Biology at Lancaster University (UK) and Director of the Lancaster Environmental centre, one of the largest groups of environmetal researchers in Europe. He obtained his first degree in Horticultural Science from the University of Reading (UK) and his PhD in Forestry and Botany from the University of Wisconsin, Madison (USA). His research interests include regulation of growth and functioning of plants experiencing environmental stress; stomatal physiology, root to shoot communication via chemical signalling in plants; environmental physiology of crops and native species; crop improvement for water-scarce environments; irrigation science and enhancing the efficiency of crop water use through novel management techniques. He has published more than 200 papers in international plant science journals and edited 17 books. He is a member of the ISI database of 'Highly Cited Researchers' in Plant and Animal Sciences. He is a member of the Defra Horticulture

Link programme Management Committee and editor-in-chief of the *Journal of Experimental Botany*.

Chapter 13.

Meira Ziv is a Professor in the Robert H Smith Institute of Plant Science and Genetics at the Hebrew University of Jerusalem (Israel). Her research interests are in the physiology and morphogenesis of plant organogenesis and somatic embryogenesis in large scale liquid cultures; shoot-malformation, hyperhydricity and the role of oxidative stress in the control of plant development in bioreactor cultures for efficient acclimatization and survival *ex vitro*; bulb and corm development in geophytes cultured in liquid cultures in relation to carbohydrate metabolism.

Jianxin Chen is a research scientist in the Department of Biology at Brock University, Ontario (Canada). His interests are in large-scale micropropagation, metabolic pathways and cloning of medicinal plants and plant breeding.