

# Growth and Development in Plants

**K.V. Krishnamurthy**

21st Century Biology and Agriculture : Textbook Series

*Series Editor : Anantanarayanan Raman*





*21st Century Biology and Agriculture*

# Growth and Development in Plants

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*Published by:*

Scientific Publishers (India)  
5 A, New Pali Road, P.O. Box 91  
JODHPUR – 342 001 (India)

Scientific Publishers (India)  
4806/24, Ansari Road, Daryaganj  
NEW DELHI – 110 002 (India)

E-mail: [info@scientificpub.com](mailto:info@scientificpub.com)

Website: [www.scientificpub.com](http://www.scientificpub.com)



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*Cover illustration:* This textbook series *Biology and agriculture for the twenty-first century* launched by Scientific Publishers, Jodhpur (India), celebrates the native, but critically threatened bird of the western semi-arid grasslands and scrubs of India, the great Indian bustard (GIB) *Ardeotis nigriceps* (Gruiformes: Otididae). GIB has been a part of Indian culture and tradition, known as *gonādh* (Sanskrit), because the male GIB's call closely resembles the mooing of cows. Artist: Urvashi Sharma.

ISBN: 978-81-7233-945-6

eISBN: 978-93-86237-20-0

Printed in India

## Series Preface

With great pleasure, the Scientific Publishers (Jodhpur) and I launch the second volume of the postgraduate textbook series under the general title *21<sup>st</sup> Century Biology and Agriculture* for use in the Indian subcontinent.

This series aims at fulfilling the knowledge needs of postgraduate learners in agriculture and biology, focussing on self-directed learning. Keeping this point in full view, these volumes would dilate on contemporary information in chosen themes in a pertinent, but brief backdrop of historical knowledge, with appropriate textual information laced with relevant illustrations. Most importantly, these books aim to cater to the self-learning needs in passionate and committed learners. By self-learning, the teacher's role turns into mentoring rather than tutoring. Vital details have been 'box'ed so that learners can internalize them easily, swiftly, and forever. Care has been exercised to integrate examples from the Indian subcontinent, so that the learners can relate to concepts and integrate principles quickly. The most critical aspect is the inclusion of specific-case studies and interactive-mode of learning so that learners can learn about the day-today issues and application of theory that surround the nominated theme effectively. Every effort has been meticulously made to see that the books launched under this series are easily readable and user-friendly. Tanay Sharma of Scientific Publishers (Jodhpur) readily agreed to my demand to identify and recruit an efficient copy editor, who has done a neat job.

This book entitled *Growth and Development in Plants*, executed by K.V. Krishnamurthy, a distinguished plant biologist, and was a professor at Bharathidasan University, Tiruchirapalli, Tamil Nadu, of India is the second in this series. Many more similar titles have been enlisted and will be appearing in the near and far future. Scientific Publishers (Jodhpur) and I thank Krishnamurthy for readily and willingly accepting to our request by executing this task, and importantly doing it speedily.

India is a land of varied landscapes. One of the remarkable natural icons of India is the Great Indian Bustard, the populations of which are restricted to Western India. Because this series is being published from Jodhpur, I thought it will be appropriate to remind ourselves of the uniqueness of this splendid bird and make every effort of conserve its diminishing population.

All books to appear in the series *21<sup>st</sup> Century Biology and Agriculture* will celebrate this Indian icon.

I am confident that learners will benefit from the information and knowledge shared by Krishnamurthy; I am also confident that post-graduate class teachers of biology and agriculture in the Indian subcontinent would find this material appropriate to prescribe this book as a learning resource.

**Anantanarayanan Raman**

Editor-in-Chief, Textbook Series

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# Preface

The purpose of the book is to provide a broad explanation on growth and development in plants from seed germination to vegetative growth, maturation and flowering, fruiting and seeding. The book presents the principles and results of previous and ongoing research on plant growth and development throughout the world. Researchers have been interested in plant growth and development for at least the past two centuries. However, their interests have been largely reductionistic and not holistic. They have concentrated their attention all along exclusively on addressing the problem of growth and development from morphological, anatomical, biochemical, physiological, molecular, environmental or genetical angles but not trying to make an integrated study. Also they focused their attention on studying growth and development by exclusively laying emphasis on different hierarchical levels of plant organization i.e. at the cellular, tissue and organ levels, again not attempting to integrate the information obtained from all these hierarchical levels. Some concentrated on in vivo approaches, others on in vitro approaches, some focusing on normal growth and development and yet others on abnormal growth and development. This book tries to integrate all the information drawn from these reductionistic approaches and provides a holistic account on plant growth and development. This is done first through detailed accounts on the various concepts and definitions, on cell division, cell cycle and cell enlargement which form the basis of growth and development, on growth regulators and signaling molecules, and on the attainment of form (morphogenesis) as related to function, at all hierarchical levels of plant organization. A detailed account on vegetative and reproductive growth and development, growth movements and rhythmic growth phenomena is provided. The role of alternative growth strategies and abnormal growth phenomena in the understanding of normal growth and development is also emphasized.

Because of space limitations, the author has concentrated his attention on flowering plants with very little focus on other groups of plants. The author also has not covered the entire gamut of the subject of plant growth and development but has summarized what he has as felt as very important. This book is meant for all those students, researchers and teachers who are curious about how plants grow and develop and what biotic and abiotic factors control growth and development. They will find

this book useful in their careers in plant biology, biotechnology, forestry, horticulture and seed science.

I am very grateful to Dr. A. Raman, Editor-in-Chief, Text book Series 21<sup>st</sup> Century Biology and Agriculture School of Agricultural and Wine Sciences Charles Sturt University Orange, NSW 2800, Australia and Mr. Tanay Sharma, Scientific Publishers, India for inviting me to write this book. I am very indebted to my wife Brindha, who has gracefully and patiently tolerated my negligence of the family during the writing of this book and who has constantly been the strongest pillar of support to me. I am also indebted to my son Arvind, daughter-in-law Anusha and grandson Sundar for foregoing the time they would have otherwise spent with me. My thanks are also to Sri Darshan Shankar, Dr. Padma Venkat and John Adams for their support and constant encouragement. I am also thankful to those people who have allowed me to use their illustrations in this book.

**K.V. Krishnamurthy**

17-02-2015  
Bangalore



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