

Climate-Smart Crop Physiology

Climate-Smart Crop Physiology

Dr. Ashutosh Kumar

Assistant Professor (Plant Physiology)
Department of Basic Science, College of Agriculture
Rani Lakshmi Bai Central Agricultural University, Jhansi

Dr. Anil Kumar Dogra

Assistant Professor (Botany), Government Degree College
Khour, Jammu (J&K Higher Education Department)

Dr. Kousik Atta

Assistant Professor (Plant Physiology & Biochemistry)
Department of Plant Physiology & Biochemistry
GLA University, Mathura, Uttar Pradesh

Mr. Lukram Shantikumar

Assistant Professor (Plant Physiology)
Department of Basic Sciences and Humanities, College of Horticulture
and Forestry, Central Agricultural University (Imphal), Pasighat



VITAL BIOTECH PUBLICATION

Kota, Rajasthan, India

<http://www.vitalbiotech.org/bookpublication/>

An International Publishers

VITAL BIOTECH get Accredited by following International organization



<https://www.portico.org/publishers/vital/>

101 Greenwich Street, 18th Floor
New York, NY 10006

Copyright © 2026 VITAL BIOTECH PUBLICATION

Published by Vital Biotech Publication

First Edition: 2026

All Rights Reserved

No part of this book may be reproduced in any form, by photostat, microfilm, xerography, or any other means, or incorporated into any information retrieval system, electronic or mechanical, without the written permission of the publisher.

Product Form:

Digital download, online and hard bound

Edition:

ISBN: 978-81-69356-21-3

Head, Production (Higher Education and Professional) & Publishing Director

Dr. Jitendra Mehta

Product Manager

Aman Saxena

General Manager

Jaya Mehta

Graphic Designer

Kritika Lohomi

Information contained in this work has been obtained by Vital Biotech Publication (India), from sources believed to be reliable. However, neither Vital Biotech Publication (India) nor its authors guarantee the accuracy or completeness of any information published herein, and neither Vital Biotech Publication (India) nor its authors shall be responsible for any errors, omissions, or damages arising out of use of this information. This work is published with the understanding that Vital Biotech Publication (India) and its authors are supplying information but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be required.

Office Address:

VITAL BIOTECH PUBLICATION

772, Basant Vihar, Kota,
Rajasthan-324009 India

Visit us at: <http://www.vitalbiotech.org>

Contact No. +91-9784677044

Printed at: Vital Biotech Publication, Kota

Preface

Climate change is reshaping agricultural production by altering temperature regimes, rainfall patterns, atmospheric carbon dioxide concentrations, and the frequency of droughts, floods, heat waves, and other extreme events. These changes directly influence crop growth, development, resource use, productivity, and quality. In this context, understanding crop physiological responses to environmental stress is fundamental to developing resilient and sustainable agricultural systems. *Climate-Smart Crop Physiology* presents an integrated perspective on the physiological mechanisms that enable crops to respond, adapt, and maintain productivity under changing climatic conditions.

The book brings together contemporary concepts in photosynthesis, respiration, water relations, nutrient acquisition, root–shoot interactions, phenology, reproductive development, and source–sink relationships, with particular emphasis on their responses to heat, drought, salinity, flooding, elevated CO₂, and combined stresses. It also highlights physiological and biochemical mechanisms underlying stress tolerance, including antioxidant defense, osmotic adjustment, hormonal regulation, molecular signaling, and metabolic plasticity.

Special attention is given to climate-smart approaches such as precision crop management, physiological phenotyping, remote sensing, protected cultivation, efficient water and nutrient management, and the use of resilient crop varieties. Emerging tools in genomics, biotechnology, artificial intelligence, and digital agriculture are discussed as complementary strategies for translating physiological knowledge into practical crop improvement and management.

This book is intended to serve as a valuable resource for students, teachers, researchers, plant breeders, agronomists, and agricultural professionals. It aims to strengthen the understanding of crop physiology while encouraging innovative approaches for achieving productivity, resource efficiency, and food security in a changing climate.

Dr. Ashutosh Kumar
Dr. Anil Kumar Dogra
Dr. Kousik Atta
Mr. Lukram Shantikumar

Dated - 15 Aug., 2026

CONTENTS

S. NO.		PAGE NO.
1.	Foundations of Climate-Smart Crop Physiology	1-16
2.	Physiological Responses of Crops to Climate Change	17-32
3.	Photosynthesis and Carbon Assimilation under Changing Climates	33-48
4.	Water Use Efficiency and Drought Adaptation Mechanisms	49-68
5.	Heat Stress Physiology and Thermotolerance in Crops	69-86
6.	Cold and Frost Stress: Physiological Adaptations in Agricultural Crops	87-106
7.	Root System Architecture and Resource Acquisition under Climate Stress	107-126
8.	Climate-Smart Nutrient Use Efficiency and Plant Metabolism	127-142
9.	Plant Hormones and Stress Signaling Networks in Climate Resilience	143-158
10.	High-Throughput Phenotyping for Climate-Resilient Crop Improvement	159-174
11.	Remote Sensing and AI Applications in Climate-Smart Crop Physiology	175-192
12.	Biostimulants, Microbial Interactions, and Physiological Resilience	193-208

