



The ABA receptors – we report you decide

Peter McCourt¹ and Robert Creelman²

The plant hormone abscisic acid (ABA) has been implicated in a variety of physiological responses ranging from seed dormancy to stomatal conductance. Recently, three groups have reported the molecular identification of three disparate ABA receptors. Unlike the identification of other hormone receptors, in these three cases high affinity binding to ABA rather than the isolation of ABA insensitive mutants led to these receptor genes. Interestingly, two of the receptors encode genes involved in floral timing and chlorophyll biosynthesis, which are not considered traditional ABA responses. And the third receptor has been clouded in issues of its molecular identity. To clearly determine the roles of these genes in ABA perception it will require placing of these ABA-binding proteins into the rich ABA physiological context that has built up over the years.

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Current Opinion in Plant Biology 2008, 11:474-478

This review comes from a themed issue on
Cell Signaling and Gene Regulation
Edited by Jason Reed and Bonnie Bartel

1522-0265/5 – see front matter
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DOI: 10.1016/j.pbi.2008.06.014

Introduction

The study of plant hormone signaling has always been a tricky business because these small organic molecules at first glance appear to do everything. If we were ever going to demystify these compounds at a mechanistic level, we would need to know how they are perceived and how changes in concentration are transduced into a cellular response. Over the past few years plant biologists have made great inroads into understanding how hormones are perceived with the molecular identification of many of the key hormone receptors [1,2]. In most of these cases, the trick was to identify a mutant in *Arabidopsis* that did not respond correctly to the hormone of interest and then through map-based cloning identify the gene. In some cases (e.g. ethylene, cytokinins and brassinosteroids), candidate genes showed some homology to receptor-like kinases from other organisms, suggesting these were receptors. However, in the case of auxin and gibberellins

the receptor function was less obvious so biochemistry was needed to unequivocally convince researchers that the genetics had succeeded.

Unfortunately, the application of forward genetics to identify the abscisic acid (ABA) receptor(s) has not had the same success as other hormone mutant hunts. For ABA mutant screens, inhibition of seed germination by exogenous ABA has been the assay of choice. By looking for seeds that germinate in the presence of ABA, a collection of mutants (designated *abi* for ABA insensitive) were identified [3,4]. Of these, five *ABI* genes have been extensively characterized at the molecular level (Figure 1a). The *ABI1* and *ABI2* genes encoded related type 2C phosphatases, suggesting phosphorylation is an important aspect of ABA signaling [5–7]. Moreover, dominant mutations in either of these genes reduce many ABA responses in *Arabidopsis* including seed dormancy, stomatal closure, inhibition of root growth and ABA-regulated gene expression, suggesting these proteins function early in the ABA signal transduction pathway. By contrast *ABI3*, *ABI4* and *ABI5* appear to be mostly limited to influencing seed related ABA responses [8–10]. These genes encode three disparate transcription factors, which by inference would suggest they are at the end of a seed-specific ABA signaling pathway. So far, epistatic analysis has not yielded a clear relationship of these gene products to each other. Coupled with a lack of biochemical studies, these deficiencies have made it unclear what role *ABI* genes play in ABA signaling.

At first glance, there are a number of possibilities as to why the forward genetics approach may not have worked. First, it is possible that mutations in the ABA receptor are lethal to the plant. This would be surprising since auxotrophic mutations exist that greatly reduce ABA levels and these mutants are still viable [11]. Possibly there is genetic redundancy in ABA perception, hence loss of any one member of the family results in a phenotype that is too subtle and escapes the watchful eye of geneticists. Certainly, all the other characterized hormone receptors are members of larger families so we would expect the ABA receptor should be no different. However, redundancy did not stop genetics from identifying receptors in the other hormone pathways so why should it be a problem for ABA? Perhaps screens need to get more sophisticated than simply a generic germination assay so that subtle phenotypes expected from genetically buffered pathways can be observed. The third possibility is the ABA receptor has phenotypes that are unexpected. In this scenario, the loss-of-function mutants in the receptor may have already been identified but the

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Girdhar K. Pandey



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Elucidation of Abiotic Stress Signaling in Plants Girdhar K. Pandey, 2015-05-30 Abiotic stresses such as high temperature low temperature drought and salinity limit crop productivity worldwide Understanding plant responses to these stresses is essential for rational engineering of crop plants In Arabidopsis the signal transduction pathways for abiotic stresses light several phytohormones and pathogenesis have been elucidated A significant portion of plant genomes most studies are Arabidopsis and rice genome encodes for proteins involves in signaling such as receptor sensors kinases phosphatases transcription factors and transporters channels Despite decades of physiological and molecular effort knowledge pertaining to how plants sense and transduce low and high temperature low water availability drought water submergence and salinity signals is still a major question before plant biologists One major constraint hampering our understanding of these signal transduction processes in plants has been the lack or slow pace of application of molecular genomic and genetics knowledge in the form of gene function In the post genomic era one of the major challenges is investigation and understanding of multiple genes and gene families regulating a particular physiological and developmental aspect of plant life cycle One of the important physiological processes is regulation of stress response which leads to adaptation or adjustment in response to adverse stimuli With the holistic understanding of the signaling pathways involving not only one gene family but multiple genes or gene families plant biologists can lay a foundation for designing and generating future crops that can withstand the higher degree of environmental stresses especially abiotic stresses which are the major cause of crop loss throughout the world without losing crop yield and productivity *Abiotic Stress Adaptation in Plants*, 2010

Abiotic and Biotic Stress in Plants Arun Shanker, Chitra Shanker, 2016-02-17 The impact of global climate change on crop production has emerged as a major research priority during the past decade Understanding abiotic stress factors such as temperature and drought tolerance and biotic stress tolerance traits such as insect pest and pathogen resistance in combination with high yield in plants is of paramount importance to counter climate change related adverse effects on the productivity of crops In this multi authored book we present synthesis of information for developing strategies to combat plant stress Our effort here is to present a judicious mixture of basic as well as applied research outlooks so as to interest workers in all areas of plant science We trust that the information covered in this book would bridge the much researched area of stress in plants with the much needed information for evolving climate ready crop cultivars to ensure food security in the future

Transgenic Crop Plants Chittaranjan Kole, Charles Michler, Albert G. Abbott, Timothy C. Hall, 2010-01-26 Development of transgenic crop plants their utilization for improved agriculture health ecology and environment and their socio political impacts are currently important fields in education research and industries and also of interest to policy makers social activists and regulatory and funding agencies This work prepared with a class room approach on this multidisciplinary subject will fill an existing gap and meet the requirements of such a broad section of readers Volume

2 with 13 chapters contributed by 41 eminent scientists from nine countries deliberates on the utilization of transgenic crops for resistance to herbicides biotic stress and abiotic stress manipulation of developmental traits production of biofuel biopharmaceuticals and algal bioproducts amelioration of ecology and environment and fostering functional genomics as well as on regulations and steps for commercialization patent and IPR issues and compliance to concerns and compulsions of utilizing transgenic plants

Plant Responses to Drought and Salinity stress, 2011-05-10 Advances in Botanical Research publishes in depth and up to date reviews on a wide range of topics in plant sciences Currently in its 57th volume the series features a wide range of reviews by recognized experts on all aspects of plant genetics biochemistry cell biology molecular biology physiology and ecology This thematic volume describes developments in understanding of plant responses to drought and salinity in post genomic and are evaluated by world wide known experts Multidisciplinary reviews written from a broad range of scientific perspectives For over 40 years series has enjoyed a reputation for excellence Contributors internationally recognized authorities in their respective fields

Abscisic Acid: Metabolism, Transport and Signaling Da-Peng Zhang, 2014-10-10 This book provides a comprehensive review of all aspects of the molecular and cell biology of abscisic acid ABA metabolism transport and signal transduction covering our current understanding of ABA as well as research trends The agricultural significance of ABA metabolism transport and signal transduction is also discussed The phytohormone ABA regulates many aspects of plant development and plays a central role in plant adaptation to environmental stresses Over the past few decades considerable advances have been made in the study of ABA metabolism transport and signal transduction greatly deepening our understanding of the underlying mechanisms of ABA function at the molecular cell and whole plant level and helping us improve crops environmental tolerance This book provides a valuable resource for researchers and advanced students interested in plant biology and agriculture

Plant Developmental Biology - Biotechnological Perspectives Eng Chong Pua, Michael R. Davey, 2009-10-29 Many exciting discoveries in recent decades have contributed new knowledge to our understanding of the mechanisms that regulate various stages of plant growth and development Such information coupled with advances in cell and molecular biology is fundamental to crop improvement using biotechnological approaches Two volumes constitute the present work The rst comprising 22 chapters commences with introductions relating to gene regulatory models for plant development and crop improvement particularly the use of Arabidopsis as a model plant These chapters are followed by specific topics that focus on different developmental aspects associated with vegetative and reproductive phases of the life cycle of a plant Six chapters discuss vegetative growth and development Their contents consider topics such as shoot branching bud dormancy and growth the development of roots nodules and tubers and senescence The reproductive phase of plant development is in 14 chapters that present topics such as floral organ initiation and the regulation of flowering the development of male and female gametes pollen germination and tube growth fertilization fruit development and ripening seed development dormancy germination and apomixis Male sterility and self incompatibility are

also discussed *Phytohormones And Patterning: The Role Of Hormones In Plant Architecture* Esra Galun,2010-06-25
 Written by an experienced researcher in the field Phytohormones and Patterning provides the most up to date and comprehensive information on the processes involved in the patterning of plant organs and tissues as well as the role of phytohormones in organ development It also provides an account of the molecular genetic bases of plant architecture with several hundred references included to facilitate easier literature search of this important field Although plant patterning and plant hormones are very active fields of endeavor there are limited reviews focussing on specific topics such as root patterning and short apex differentiation This book which deals with the subject matter extensively will provide a much needed comprehensive discussion on the entire scope of plant patterning and the impact of phytohormones on patterning which was otherwise missing Students studying plant development will benefit greatly from the book as will undergraduates in agricultural studies and those studying plant genetics and plant breeding As the book covers a wide range of topics it will also be useful for researchers who may be interested in possible new fields and to readers who may not be experts but who are interested to enhance their knowledge of plant development **Plant Roots** Amram Eshel,Tom Beeckman,2013-04-17
 The decade since the publication of the third edition of this volume has been an era of great progress in biology in general and the plant sciences in particular This is especially true with the advancements brought on by the sequencing of whole genomes of model organisms and the development of omics techniques This fourth edition of Plant Roots The Hidden Half reflects these developments that have transformed not only the field of biology but also the many facets of root science Highlights of this new edition include The basics of root research and their evolution and role in the global context of soil development and atmosphere composition New understandings about roots gained in the post genomic era for example how the development of roots became possible and the genetic basis required for this to occur The mechanisms that determine root structure with chapters on cellular patterning lateral root and vascular development the molecular basis of adventitious roots and other topics Plant hormone action and signaling pathways that control root development including new chapters on strigolactones and brassinosteroids Soil resource acquisition from agricultural and ecological perspectives Root response to stress with chapters that address the impact of the genomic revolution on this topic Root rhizosphere interactions from beneficial microorganisms to detrimental nematodes Modern research techniques for the field and the lab Each chapter not only presents a clear summation of the topic under discussion but also includes a vision of what is to be expected in the years to come The wide coverage of themes in this volume continues the tradition that makes this work recognized as a fundamental source of information for root scientists at all levels **Биосинтез тетрапирролов в растениях** Наталия Аверина,Елена Яронская,2014-08-03 5 IX **Agriindex** ,1994 Books in Print ,1991

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