Phytohormones in Plant Biotechnology and Agriculture

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PREFACE

Phytohormone research is a crucially important area of plant sciences. Phytohormones are one of the key systems integrating metabolic and developmental events in the whole plant and the response of plants to external factors. Thus, they influence the yield and quality of crops. During the last decade we have slowly begun to understand the molecular mechanisms underlying phytohormone action, largely as a result of the rapid developments that have been made internationally in the field of plant molecular genetics. Putative receptor proteins for ethylene (1993-95), brassinosteroids (1997) and cytokinins (2001) have been identified and the genes that encode them cloned. Primary response genes and elements of hormonal signal transduction have also been identified for most known phytohormones. There is now little doubt that phytohormones, like their animal counterparts, function as signal molecules and create a signalling network in the whole plant organism.

The *in vivo* activity of hormones depends, among other things, on their rate of biosynthesis and metabolism, and on their transport into and out of target cells. Consequently, genes and enzymes involved in these processes are of particular interest. In recent years a number of genes encoding enzymes for the synthesis, modification and degradation of different phytohormones have been cloned and identified, as have genes encoding proteins involved in phytohormone transport and its regulation. Some classes of phytohormone have been shown to participate in stress reactions and can increase the resistance of plants to unfavorable environmental factors. All the developments mentioned above provide potentially powerful tools for the creation of new plant forms with desirable properties for modern biotechnology, agriculture and horticulture. Indeed, new transgenic or mutant plants have recently been produced showing altered hormonal status or sensitivity. Such plants are now under intensive investigation in laboratories in many parts of the world.

Recent advances in phytohormone research and practical applications of this research were discussed at the NATO-Russia Advanced Research Workshop “Phytohormones in Plant Biotechnology and Agriculture”, held in May 2002 at the Institute of Plant Physiology of the Russian Academy of Sciences, Moscow. The Workshop was dedicated to the centenary of the birth of the famous Russian plant physiologist, Academician Mikhail Chailakhyan (1902-2002). Chailakhyan pioneered investigations into the hormonal regulation of flowering, and of the flowering hormone “florigen”. He quickly appreciated the potential for the application of the results of phytohormone research in agriculture and horticulture, and was one of the first to use gibberellin treatments in seedless grape production.

This book contains papers written by lecturers and selected participants in the Workshop. The main topics centre around: molecular aspects of phytohormone action and transport; phytohormones and flowering; phytohormones and stress; the

use of phytohormones in plant biotechnology and agriculture; and the use of transgenic plants. In our opinion, the book reflects not only current progress and achievements in phytohormone research, but also the high degree of international co-operation and friendship that were a feature of the Workshop.

We would like to sincerely thank the North Atlantic Treaty Organization, the sponsors of the workshop, for their support. This enabled the workshop to achieve a high international standard. We are especially grateful to the NATO Scientific Affair Division, represented by Dr. Alain Jubier who personally attended the first day of the

Workshop. We also acknowledge with thanks the Russian Ministry of Industry, Science and Technology and Professor Nikolaus Amrhein (ETH Zurich, Switzerland) for their financial support and Professor Vladimir Kuznetsov, Director of the Moscow' Institute of Plant Physiology for providing all necessary facilities for workshop organisation.

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COLOUR PLATES

Davies et al.: Figure 13. The false-colour image of light emitted by transgenic *Arabidopsis* plants containing the firefly luciferase (LUC) reporter gene coupled to the *AtGA20ox1* promoter demonstrates that the *GA20ox1* gene is expressed most strongly in the shoot apex and in young developing leaves. (From P. Hedden, IAACR-BBSRC annual report, 2000.)

Davies et al.: Figure 18. (A) Left: Cytokinin signalling is initiated by CKII, a histidine protein kinase receptor, in the absence of cytokinin. Protoplasts were cotransfected with CKII and the *ARR6-LUC* reporter gene and the luciferase activity recorded. Right: The CKII (as detected in protoplasts transfected with CKII-GFP) is localized at the plasma membrane. (B) Cytokinin signalling intermediate AHP acts as a shuttle between the cytoplasm and nucleus in cytokinin signalling. Left: Overexpression of AHP (as detected by the *ARR6-LUC* reporter) does not affect cytokinin signalling; CK is still needed. However CK causes a relocation of AHP (as detected in protoplasts transfected with AHP1-GFP) to the nucleus (right). (From Hwang and Sheen, 2001.)

Bou et al.: Figure 1. Slender phenotype and tuberization response of the antisense phyB lines. Only the phyB lines tuberize in LD. These plants have paler leaves and an elongated stems due to increase internode length.

Bou et al.: Figure 4. Phenotype of the phyB 20ox antisense lines. (A) Down-regulated expression of the phyB and StGA20ox1 transcripts in the phyB 20ox lines. (B) Dwarf phenotype of the phyB 20ox mutants. The leaves of these plants show still a pale phenotype, which indicates that this trait is not dependant on Gas.