accumulation via increased gene expression and activity of ROS-detoxifying enzymes. Different stimuli activate specific H_2O_2 generating pathways and produce the signal leading to specific physiological processes (Neil *et al.*, 2002).

Although it is hypothesized that H_2O_2 produced intracellularly diffuses to other cells for use by POX and other defensive enzymes, it non appearance more probable that intracellularly produced H_2O_2 is consumed quickly and locally, and that extracellular metabolism uses H_2O_2 produced extracellularly. H_2O_2 localization with in tissues, sometimes to portions of cell wall in root hairs, or in epidermal cells in association with wounding or stomatal movements, indicates as does compartmentation at the tissue level within the leaves, in vascular tissues, and in areas of regulation (Naves et al., 1998). During oxidative stress H_2O_2 is shown to induce stomatal closure (McAnish et al., 1996) showed that elicitors could induce H₂O₂ production and Lee *et al.* (1999), demonstrated that both these responses are linked: elicitors caused H₂O₂ production which in turn, caused stomatal closure. For H₂O₂ to really to be a specific signalling molecule, a mechanism must exist to perceive the elevation of H_2O_2 in cells. H_2O_2 can interact with cysteine residues within proteins and this redox modulation of protein can potentially alter protein conformation, affecting protein activity and, therefore, initiating subsequently cellular responses. In the last five years, this response network has been repeatedly extended and summarized, not only for stomatal responses but also for responses to other abiotic stresses, and the signalling cascade has been shown to have many similarities. Furthermore, recent work has shown that H_2O_2 induces the expression of genes encoding proteins required for peroxisome are important sources of ROS as well as antioxidant and NO, and are thus important regulators of the cellular redox state. Calmodulin regulates NAD kinase

activity, which generates NADPH for NADPH oxidase activity. Thus cross-talk between H_2O_2 and calcium can regulate specificity and/or cross-tolerance towards various abiotic stresses. To date, though, no calciumdependent protein kinases have been shown to be regulated by H_2O_2 , although H_2O_2 regulated genes encoding protein kinases and phosphatases have been discovered. More lines of evidence concerning the relationship between H_2O_2 and Ca^{2+} signals is provided by the study of H_2O_2 homeostasis in Arabidopsis. In last, a protein phosphorylation cascade that has been shown to be activated by H₂O₂ in a MAPK cascade. This kinase then phosphorylated a MAPKK which in turn activates a MAPK by dual phosphorylation on both threonine and tyrosine residues in a conserved T-X-Y motif. Different previous observations indicate that H_2O_2 activating of a MAPK cascade is a central response mediating tolerance of various stresses: (1) that H_2O_2 generation occurs in response to diverse abiotic stresses, (2) that exposure to one stress offers crosstolerance towards another, (3) that there exist commonalities in defence responses to various stresses, and (4) that activation of a H_2O_2 regualed MAPK pathway mediates multiple stress tolerance.

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Future Challenges

The intracellular signalling cascades that transduce H_2O_2 perception into cellular responses have so far been characterized only superficially. Finally, they raise the question of how H_2O_2 is detected by cells. Such perception can conceivably involve direct interaction of H_2O_2 and other signalling molecule with cellular proteins such as transcription factors, ion channels or enzymes. H_2O_2 is a strong toxic oxidant causing cell damage or even cell death. At the same time, it serves conversely as a signalling molecule to activate a defence system for restoring the redox homeostasis in plant cells. The data

different stresses include whether several of the different stresses capable of eliciting the response have common negative physiological effects and assessment of whether alternations in proline metabolism may ameliorate these consequences (Llops-Tous *et al.*, 2011).

As an alternative pathway, proline can be synthesized from ornithine, which is transmitted first by ornithine-delta-aminotransferase (OAT) providing GSA and P5C, which are then converted to proline. Proline catabolism occurs in mitochondria via the sequential action of proline dehydrogenase or proline oxidase (PDH/POX) producing P5C from proline, and P5C dehydrogenase (P5CDH), which converts P5C to glutamate. PDH is encoded by the two genes, whereas a single P5CDH gene has been identified in Arabidopsis and tobacco (Ribarits et al., 2007). Proline accumulation induced by stress conditions is mediated both by increased synthesis and reduced oxidation of the imino acid. Metabolic labelling studies also mediate that most of the proline accumulated in plants in response to stress is the results of enhanced synthesis from glutamate. The soluble protein and free amino acid in barley organs (root and bud) increased with NaCl increasing. Central role in cellular homeostasis against environmental stress (salinity and drought stress). One mechanism utilized by the plants for overcoming the salt stress effects might be via accumulation of compatible osmolytes, such as proline and soluble sugar. Production and accumulation of free amino acids, especially proline by plants tissue during drought, salt and water stress is an adoptive response.

Moreover, marked changes in the content of proline are observed, with some specific variations associated with the different organs of *L. albus* concerning the effects of boron deficiency in the metabolism indicate that various aspects of metabolism implicated in the amino acid accumulation affected by boron deficiency (Marin *et al.*, 2010). Also, proline increase in many other kinds of stresses and accumulated in petioles, apexes and hypocotyls. The increase in the proline concentration observed in all organs, suggests the involvement of boron with the cytoskeleton, whereas glycine decrease in leaf-blades and active growing organs like apexes and roots could be associated with the proposed role of glycine in plant signalling in processes that might be associated with the decreased growth rates observed in boron deficiency. The salt stress conditions could have effect on different stages of N metabolism, such as absorption, ionic reduction and protein synthesis. Proline content also higher in tolerant variety as compared to their lower accumulation in sensitive variety. The improved performance of the tolerant variety under high salinity accompanied by an increase in ascorbate peroxidase and catalase, though no salt-dependent increase in the activity of superoxide dismutase observed. Increased photoinhibition in sensitive variety observed by its reduced thylakoid membrane protein, D1 probably results from the greater photosynthetic damage caused by salt stress than tolerant variety (Mishra and Dubey, 2006). However, the correlation between proline accumulation and abiotic stress tolerance in plants not always apparent. For an instance, high proline levels can be characteristics of salt and cold hypersensitive Arabidopsis mutants (Chen et al., 2007). During adaptation to various types of environmental stress, plants accumulate cellular solutes which include quaternary amino acid derivatives such as proline, glycine betaine alanine, betaine and proline betaine (Patakas et al., 2002). Still however, the relationship between this trait and stress tolerance is not clear among species. As a case, members of solanacese family, can increase their proline pool by more than two orders of magnitude and others exhibits only a moderate increase in proline content under stress. Moreover, other researchers have

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Molecular Approach of Auxin Functionality to Enhance Yield Potential of Crops

ABSTRACT

The auxin is a molecule similar to tryptophan, yet it elicits a diverse array of responses and is involved in the regulation of growth and development throughout the plant life cycle. The versatile functionality and physiological importance of the auxin is a major focus of attention in contemporary areas of advanced plant physiology. This ability to bring about such diverse responses appears to result partly from the existence of several independent mechanisms for its perception and signal transduction that involves the intentional degradation of various members of transcriptional regulator family, participating the complex and competing dimerization networks to modulate the expression of a wide range of genes targeted for physiological responses in plant. Forward and reverse genetic advances resulted in the identification of some of the underlying regulatory mechanisms as well as the emergence of functional frameworks for auxin action. In this review, we also shade a small beam of light on homeostatic regulation of auxin levels embraces various other endogenous auxins and described mechanism of auxin action including processes of downstream stress signal perception and transduction as well.

Keywords: Hormone, signal transduction, auxin, plant growth regulators and receptor.

INTRODUCTION

Phytohormones are important plant growth regulators that control many developmental processes such as cell division, cell differentiation, organogenesis and morphogenesis. They regulate a multitude of apparently unrelated physiological processes, often with overlapping roles, and they mutually modulate their effects. These features imply important synergistic and antagonistic interactions between the various plant hormones (Bielach *et al.*, 2012). Among them, Auxin is identified as a plant growth hormone because of its ability to stimulate differential growth in response to light stimuli. Studies of auxins originated in investigations of bending responses of coleoptiles towards a light source. The signal perceived by the coleoptiles top is shown to be transported asymmetrically from the tip downward, where it induced growth response due to differential elongation of one side of the coleoptiles (Went *et al.*, 1928). Much of our knowledge of the physiological role of auxin in plants is delivered from studies on how plants respond to excess exogenous auxin. However, an equally important aspect of auxin biology is to characterize the developmental defects caused by auxin deficiency, which cannot be achieved without a clear grasp of auxin biosynthetic pathways (**Fig. 3.1**).

Auxin is probably the most investigated plant hormone and is known to be involved

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An interesting hypothesis is that IAA conjugates may be recognized at the ER (or recruited to it) by the ABP1, which also has an ER retention signal. Undoubtedly, both transcriptional and non-transcriptional actions of IAA are involved. The morphogenic action of auxin is not always connected with its concentration maxima since auxin minimum has likewise been reported to regulate organogenesis during the opening of A. thaliana fruits. IBA probably serves as an important source of IAA in tightly regulated developmental and environmental contexts. Formation of IAA from IBA in young Arabidopsis seedlings plays a role in the elongation of root hairs and in the expansion of cotyledon cells, whereas hypocotyl elongation is maintained by the pool of IAA formed from IAA-amino acid conjugates. No IAA-independent biosynthetic pathway for IBA has yet been found, it seems that IBA levels depend on the levels of IAA. Because of the presence of IAA and IBA in the model plant A. thaliana, we know much more about these two compounds than do about the two other endogenous auxins, 4-Cl-IAA and PAA, which have not been detected in Arabidopsis. The endogenous auxin IBA contributes significantly to this free and hence active pool of IAA. It remains to be tested whether this applies also for the other two endogenous auxins.

GENETICS OF PERCEPTION AND SIGNAL TRANSDUCTION

During the past few years, remarkable progress has been made on our basic understanding of the mechanisms, genes and proteins, and regulation of auxin action, profited from the development of molecular tools particularly in Arabidopsis. IAA plays a role in wide variety of growth, developmental and physiological processes. Transport inhibitor response 1/auxin signalling F-box (*TIR1/AFB*) proteins are localized in the nucleus (Dharmasiri et al., 2005) and the mechanism of TIR1 binding to IAA, NAA and 2,4-D has been described in detail (Tan et al., 2007). Auxin serves here as a kind of molecular glue that stabilizes the interaction between the receptor and Aux/IAA repressors of ARFs, which are transcription factors that bind elements found in the promoters of many auxin-induced genes. The concentration gradients of IAA in the tissues of the Arabidopsis thaliana and other plants are important for embryogenesis shoot and root organogenesis including apical dominance, vascular tissue development and differential growth during tropisms and apical hook development. IAA gradients may also be decisive in senescence, plant-pathogen interactions, abiotic stress responses and other reactions of plants to the environment interaction (Wang *et al.*, 2010) (**Fig. 3.3**).

Auxin signalling is assumed to start with the perception of auxin by its interaction with some kind of receptors. Evidence suggests that there are multiple sites for auxin perception, and in this sense, auxin can be considered to be multifunctional in that the auxin signal appears to be transduced through various signalling pathways. The auxin conjugates can then be hydrolyzed by the enzymes also localized in the ER. However, the subcellular localization cannot be demonstrated for any of the known proteins. The co-localization of an auxin receptor, auxin amino acid conjugate hydrolases, and a protein with IAA attached suggest a possible, not yet identified function of the ER in auxin homeostasis/biology (Fig. 3.4).

Moreover, the best-characterized auxin binding protein is *ABP1* (Napier, 1995), which first described in maize. Excitement about the role of *ABP1* in auxin perception is driven the high specificity and affinity of its auxin binding, with a KD for the synthetic auxin NAA of 5×10^{-8} M. Some *ABP1* apparently escape to the plasma membrane, where it mediates several cellular responses to applied auxin, including tobacco mesophyll protoplast