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ROLE OF ABA AS A SIGNAL MOLECULE IN STRESS CONDITION

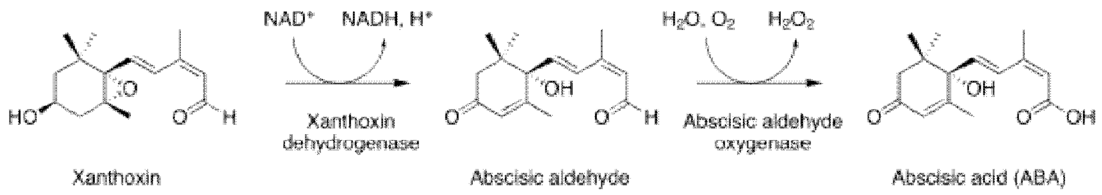
Jyoti Chauahan[1*] and Rakesh Sil Sarma[1]

Department of Plant Physiology, Banaras Hindu University.Varanasi, India.

Email of corresponding author - jc6173000@gmail.com

Introduction: Plant hormones are signal_molecules produced within the plant, and occur in extremely low concentrations. Hormones regulate cellular processes in targeted cells locally and, moved to other locations, Auxin, Cytokinine, Gibbrlrlin, Abscisic acid and Ethylene are five important class of plant hormone.

Structure and Biosynthesis of Abscisic acid:- (**ABA**) is a natural plant growth regulators, Which play important role in many plant developmental processes, such as stress response and bud dormancy. It was discovered and researched under two different names before its chemical properties were fully known, it was called *dormin* and *abscicin II*. Once it was determined that the two compounds are the same, it was named abscisic acid. Due to its role in the abscission of plant leaves ABA owes its name. In 1960, ABA was isolated and identified from cotton bolls (Adicott et al) ABA is an isoprenoid plant hormone, which is synthesized in the plastidal 2-*C*-methyl-D-erythritol-4-phosphate (MEP) pathway; unlike the structurally related sesquiterpenes, which are formed from the mevalonic acid-derived precursor farnesyl diphosphate (FDP), the C_{15} backbone of ABA is formed after cleavage of C_{40} carotenoids in MEP. Zeaxanthin is the first committed ABA precursor; a series of enzyme-catalyzed epoxidations and isomerizations via violaxanthin, and final cleavage of the C_{40} carotenoid by a dioxygenation reaction yields the proximal ABA precursor, xanthoxin, which is then further oxidized to ABA. via abscisic aldehyde



Increased ABA levels as a response to environmental stress

In plants under water stress, ABA plays a role in closing the stomata. Soon after plants are water-stressed and the roots are deficient in water, a signal moves up to the leaves, causing the formation of ABA precursors there, which then move to the roots. Abscisic acid is produced in the roots in response to decreased soil water potential (which is associated with dry soil) and other situations in which the plant may be under stress, which is translocated to the foliage through the vascular system and modulates the potassium and sodium uptake within the guard cells and alters the osmotic potential of stomatal guard cells, causing them to shrink and stomata to close. The ABA-induced stomatal closure reduces transpiration (evaporation of water out of the stomata), thus preventing further water loss from the leaves in times of low water availability. A close linear correlation was found between the ABA content of the leaves and their conductance (stomatal resistance) on a leaf area basis. Seed germination is inhibited by ABA in antagonism with gibberellin. ABA also prevents loss of seed dormancy. Chilling temperatures also increased ABA levels. From the above observations, it is evident that the extent of ABA production is positively related to the degree of resistance to a given stress factor. However these observations alone do not establish that ABA is a necessary intermediary for acquisition of stress tolerance.

ABA present in all parts of the plant and its concentration within any tissue seems to mediate its effects and function as a hormone; its degradation, or more properly catabolism, within the plant affects metabolic reactions and cellular growth and production of other hormones. Plants start life as a seed with high ABA levels. Just before the seed germinates, ABA levels decrease; during germination and early growth of the seedling, ABA levels decrease even more. As plants begin to produce shoots with fully functional leaves, ABA levels begin to increase, slowing down cellular growth in more "mature" areas of the plant. Stress from water or predation affects ABA production and catabolism rates, mediating another cascade of effects that trigger specific responses from targeted cells.

ABA as a long-distance signal mediating whole plant responses to drought and salt stresses

The involvement of ABA in mediating drought stress has been extensively researched. Salt stress resulted in intercellular accumulation of ABA during growth of tobacco cells (Singh *et al.*) and elevated endogenous levels of ABA in seedlings of alfalfa (Luo *et al.*). Mechanical injury to potato leaves resulted in an increase in ABA levels[6], and increased ABA expression of transcripts coding for protease inhibitor. Similar treatment of an ABA-deficient mutant had little effect. Young tobacco leaves had elevated levels of ABA following infection by tobacco mosaic virus (TMV). ABA plays a critical role in regulating plant water status through guard cells and growth as well as by induction of genes that encode enzymes and other proteins involved in cellular dehydration tolerance. Early work showed that ABA can act as a long-distance water stress signal in sensing incoming soil drying.

Stress ABA produced in dehydrated roots in drying soil is transported to the xylem and regulates stomatal opening and leaf growth in the shoots. This mechanism is modified by the ionic conditions and pH in the xylem have shown that pH changes play a central role in the ABA redistribution in leaf tissues and control the stomata at times when no significant changes in ABA concentration are detected in the xylem.

More recent experiments have supported the notion that ABA has dual roles in its physiological regulation. Its inhibitive role functions when it is accumulated in large amount under stress to help plant survival through inhibition of processes such as stomatal opening and plant size expansion. Its promoting role, when it is at low concentration and at more 'normal' condition, has been shown essential for vegetative growth in several organs, e.g., primary root growth and post-germination seedling development provided evidence that a short-chain dehydrogenase/reductase called SDR1 in *Arabidopsis* is involved in the sugar sensing and signaling that are essential in many metabolic processes such as germination, growth and flowering ,as well as in ABA biosynthesis by catalyzing several steps from carotenoid-derived xanthoxin to abscisic aldehyde in the cytosol.

In addition to osmotic stress, salinity imposes on plants other stresses such as ion toxicity, as a result of ion entry in excess of appropriate compartmentation, and nutrient imbalances, as commonly seen in the displacement of potassium by sodium. The main damage to plants, however, could result from osmotic stress imposed externally due to high ion concentrations in the soil or internally when excess salt uptake resulted in high salt accumulation in the intercellular spaces. In this regard, the damage caused by salinity is mainly due to altered water relations; thus plant responses to salinity and water deficit are closely related with overlapping mechanisms. Exposure of plants to salinity is known to induce a proportional increase in ABA concentration that is in most cases correlated with leaf or soil water potential, suggesting that salt-induced endogenous ABA is due to water deficit rather than to a specific salt effects.

Stress and ABA-inducible proteins

Plants synthesize a spectrum of new proteins on exposure to different environmental stresses such as water stress, salt stress, dehydration and desiccation stress, cold stress, and wounding. Proteins induced by stress fall into three categories: (i) those inducible by stress and ABA; (ii) specifically induced by stress but not by ABA; and (iii) inducible by ABA. Therefore, it is quite evident that many of these stress-responsive proteins are also induced by ABA (Table 1) and several groups of proteins listed are homologous.

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