Salinity Stress in Plants: Reactions and Mechanisms

In this article we will discuss about Salinity Stress in Plants. After reading this article you will learn about: 1. Reactions of Plants to Salinity 2. Mechanisms of Salt Resistance.

Reactions of Plants to Salinity:

The reactions of plants to salinity depend on the specific degree of tolerance against soil salinity. Plants can be classified according to their biomass production under salt stress.

Four groups are distinguished.

i. Eu-halophytes, which show stimulation of productivity at moderate salinity (e.g., Salicorneaeuropaea, Suaedamaritima).

ii. Facultative halophytes, showing slight growth enhancement at low salinity (e.g., Plantagomaritima, Aster tripolium).

iii. Non-halophytes with low salt tolerance (e.g., Hordeum sp., Gossypium sp).

iv. Halophobicplants, e.g., Phaseolus vulgaris, Glycine max, which cannot tolerate salts.

From an ecological viewpoint, halophytes can be characterised as plants that survive to complete their life cycles at high salinities.

Mechanisms of Salt Resistance:

Salt resistance is the ability of plants to tolerate excess salt in their habitat without any significant impairment of their vital functions. It is a complex combination of various mechanisms, not a single process or adaptation, and therefore not controlled by a single gene. Plants can achieve resistance to salt stress either by tolerating the stress or by avoiding it.

i. Salt Tolerance:

Tolerance to salt stress is the ability to tolerate toxic as well as osmotic effects of salt ions, like Na^+ and Cl^- ions in the cytoplasm. High concentrations of salt ions have been found in the cytosol of salt-exposed plants. Under such conditions, the cytoplasmic enzymes have to function in presence of salt ions.

This was investigated with the enzyme PEP carboxylase from halophytes Suaedamonoica and Chiorisgayana. It is the key enzyme for CO2 fixation in plant leaves. Addition of substrate PEP to the extraction and storage medium helps to stabilize the enzyme. At low PEP levels of the assay medium, the enzyme is inhibited by NaCl but at high PEP levels the enzyme was activated by NaCl.

Salt ions changed the kinetic properties of the enzyme and were suggested to function as allosteric effectors. Also other agents like betaine, proline or glycerol could stabilize PEP carboxylase. Therefore, the salt tolerance of plants may depend riot only on salt exclusion from cytosol, but also changes in the microenvironment of the enzymes, for instance on whether substrate or protective agents have been increased.

A similar mechanism of enzyme protection was found with Rubisco of the woody halophyte Tamarixjordanis. It is the key enzyme in photosynthetic carbon reduction in plants. The carboxylating activity of the enzyme was inhibited by NaCl.

However, the addition of methylproline restored the activity. Salt tolerance of T. jordanis is based on two mechanisms — increase of Rubisco content and formation of compatible solutes. Such solutes enable the Rubisco to function at high rates in presence of salt ions in cytosol.

ii. Salt Avoidance or Regulation:

In many plants, resistance to salt stress involves efficient restriction of salt uptake.

iii. Restriction of Uptake or Transport:

The foremost strategy to limit salt accumulation is the inhibition of uptake of salt ions. This can be achieved by inhibition of root uptake, which is found in mangroves. However, in most species, such a mechanism is not sufficient. Strategies have evolved to restrict salt transport into sensitive organs or tissues.

The plants sequester salt ions, which move with the transpiration stream, and thus prevent them from reaching sensitive parts of the organism. Such a mechanism was found in various species of Fabaceae.