Heavy Metal Stress in Plants

In this article we will discuss about Heavy Metal Stress in Plants. After reading this article you will learn about: 1. Subject-Matter of Heavy Metal Stress 2. Metal Toxicity in Plants 3. Tolerance of Metal Phytotoxicity.

Subject-Matter of Heavy Metal Stress:

Metals have been used in the service of the living world for thousands of years. Some of these metals influence the plant life when present only in minute quantities and controlling thereby the biochemical processes within them.

The metals generally remain bound to certain enzymes as cofactors within the plants. In such metal-activated systems, the activating cations like Mg 2+, Mn2+, Co2+, Zn2+ may be intimately involved in the formation of enzyme-substrate complex. Metals like Ca2+, Mg2+ Na+ K+ are involved in maintaining physiological-millieu suitable for life.

At the same time the increased demand for metals of all kinds, following the Industrial Revolution, was accompanied by the appearance of metal-induced diseases such as Pb, Cd or Ni poisoning.

Metals like Hg. Pb, Cd, Ni Ba Cr are non-nutrient metals which are toxic even at a very low concentration), whereas the essential elements like Mn, Mo, Zn, Cu, Co grouped as micronutrients also prove to be toxic at high concentrations.

Metal Toxicity in Plants:

Metal toxicity in plants has been known for a long time. Toxic levels of metals in soils may be caused by natural soil properties or by agricultural, manufacturing, mining and waste disposal practices. In many acid soils at or below pH 5.0, Al toxicity is an important growth-limiting factor.

Strong subsoil acidity (or Al toxicity) reduces plant-rooting depth, increases susceptibility to drought, and decreases the use of subsoil nutrients. Mn toxicity is also a problem of some strongly acid soils and mine spoils whose parent molecules are sufficiently high in Mn.

However, it can also occur at high pH levels in soils under reducing conditions created by flooding, compaction or organic matter accumulation. In this condition, i.e., high pH, the toxicity is attributed to increased solubility of a humic fraction of peat, which renders Mn more available to plants.

Soil microorganisms play a major role in determining soil levels of reduced Mn2+, which is absorbed by plants at higher soil pH levels.

Iron toxicity is involved in physiological disorders of rice plants under flooded conditions, which is due to high concentration of the reduced product Fe^{2+}in soil solution. The condition is improved by drainage, delayed submergence or the addition of reduction retardants, such as MnO_2 which counteracts iron toxicity by decreasing soluble Fe^{2+}concentration in solution.

Some plants are more sensitive, while some are less sensitive to iron. Greater Fe sensitivity is attributed to a more rapid soluble Fe (Fe^{2+}) absorption rate. It is expected that plants, which are tolerant to water-logging are also tolerant to Fe toxicity.

Roots of plant species tolerant to Fe can oxidize Fe more effectively than plants sensitive to it. Another factor providing tolerance is that the plant reduces its transport to plant tops more effectively than sensitive plants. Plants sensitive to water-logging show no ability to oxidize Fe.

Rice plants may escape Fe toxicity by:

(i) lowering Fe concentration in growth medium

(ii) excluding Fe^{2+} from roots

(iii) preventing Fe translocation from roots to tops.

Rice roots can increase reduction potential of the soil solution and thereby decrease concentration of Fe^{2+}. Plant- induced increase in redox can be enhanced by K fertilization. Rice roots secrete O_2, converts $Fe^{2+}$to Fe^{3+}, and thereby prevents its penetration of critical root zones.

Tolerance of Metal Phytotoxicity:

There is considerable genetic variation in the abilities of various species to tolerate toxic amounts of non-essential lead, cadmium, silver, aluminium, mercury, tin and other metals.

In some species, the elements are absorbed.