Plant Biochemistry & Physiology

Saha, J Plant Biochem Physiol 2015, 3:3
DOI: 10.4172/2329-9029.1000e129

Editorial Open Access

Toxic Metals and Plants

Saha B*

[1]Department of Chemistry, The University of Burdwan, Golapbag, Burdwan-713104 WB, India

Cadmium

Cadmium is a non essential element that negatively affects the plant growth and development. It is highly soluble in water. It has been reported that uptake, transport, and subsequent distribution of nutrient elements by the plants can be affected by the presence of Cd ions. In general, Cd has been shown to interfere with the uptake, transport, and use of several elements (Ca, Mg, P, and K) and water by plants. Cd reduces the absorption of nitrate and its transport from roots to shoots, by inhibiting nitrate reductase activity in the shoots. Nitrogen fixation and primary ammonia assimilation decreased in nodules of soybean plants during Cd treatments. Metal toxicity can affect the plasma membrane permeability, causing a reduction in water content. Cd involved destruction of nucleic acids, cell membrane, lipids, and proteins; reduction of protein synthesis; and damage of photosynthetic proteins, which affects growth and development of the whole organism. Cadmium treatment induces lypooxygenase with the simultaneous inhibition of antioxidative enzymes, SOD, CAT.

Arsenic

Arsenic is a potential threat for human health and the environment. Arsenite is more toxic than arsenate, and both of them are more toxic than organic arsenical compounds. Arsenate is chemicaly similar to phosphate. Arsenate competes with phosphate for the uptake system, but the affinity tophosphate is much stronger than to arsenate. Anincreased phosphate level leads to reduced arsenateuptake in plants and vice versa. Arsenic, either supplied as As(V) or As(III), causes oxidative stress and can deplete reduced glutathione, an important cellular antioxidant, through the formation of As(III)-glutathione.

Copper

Copper is an essential plant micronutrient, required for the protein components of several enzymes. However, when present in excess quantities, Cu is also highly toxic to plant. Excess of Cu in soil plays a cytotoxic role, induces stress and causes injury to plants. This leads to plant growth retardation and leaf chlorosis. Exposure of plants to excess Cu generates oxidative stress and ROS. Oxidative stress causes disturbance of metabolic pathways and damage to macromolecules.

Lead

Lead accumulation occurs in roots, stems, leaves, root nodules and seeds, etc. which increases with the increase in the exogenous lead level. Majority of the lead absorbed by plants reside in the root with only a small fraction was translocated upward to the shoots. Endodermis acts as a barrier to lead uptake to shoots. The effect of lead depends on the concentration, type of salts, soil properties and plant species involved. Led toxicity causes sharp decrease in productivity. It also causes leakage of K ions from root cells. Seed germination, seedling growth, photosynthesis, plant water status, mineral nutrition, and enzymatic activities are affected by lead. Pb inhibits chlorophyll synthesis by causing impaired uptake of Fe, Mg etc. Chlorotic spots, necrotic lesions etc. in leaf surface, senescence of leaf (due to reduced chlorophyll, DNA, RNA, protein, and dry weight, ratio of acid to alkaline pyrophosphatase activity, activities of protease and RNase), and stunted growth are also result of led toxicity. Germination of seeds is drastically affected at higher concentrations. Long term exposure results in reduced leaf growth, decreasedphotosynthetic pigments, changed chloroplast structure, and decreased enzyme activities for CO_2 assimilation.

Mercury

Mercury occurs in organic as well as in inorganic forms. Both the forms are toxic. The possible mechanism of mercury toxicity is the reaction between mercury cation and sulphydryl (-SH) group and hence can disturb almost any function where non-protected proteins are involved. It also has tendency to react with phosphate groups and active groups of ADP or ATP and replaces essential ions. A mercury ion may bind to two sites of a protein molecule without deforming the chain, or it may bind two neighbouring chains together. But sufficient high concentration of mercury causes protein precipitation. Light and dark reactions of photosynthesis are affected by mercury. Substitution of magnesium, the central atom of chlorophyll, by mercury prevents photosynthetic light harvesting in the affected chlorophyll molecules, resulting in a decrease of photosynthesis. Organomercury compounds, like methyl or butyl mercury chloride are more toxic to aquatic plants than inorganic forms. The highestdose of mercury decreased RNA, dry weight, catalase and protease activity, and increased production of free amino acids.

Zinc

Zinc is an essential element. It acts as a plant nutrient. Zinc plays an important role in mitosis. But at higher concentrations, it is toxic. In presence of excess zinc the cytoplasm becomes structureless; disintegration of cell organelles and the development of vacuoles occur. pH of a solution determines the concentration of zinc in that solution. High concentration of zinc causes stunting of shoot, curling and rolling of young leaves, death of leaf tips and chlorosis. Zinc toxicity was marked in root system particularly in root blunt, thickening and caused restraint on both cell division and cell elongation. High concentration of zinc inside a cell causes disruption and dilation of nuclear membrane. The cytoplasm became structureless; disintegration of cell organelles and the development of vacuoles were also observed.

Chromium

Chromium can cause harm to cell metabolism and development, when it is taken up by plants instead of necessary micronutrients.

***Corresponding author:** Bidyut Saha, Department of Chemistry, The University of Burdwan, Golapbag, Burdwan-713104 WB, India, Tel: 9832272318; E-mail: b_saha31@rediffmail.com

Received June 01, 2015; **Accepted** June 11, 2015; **Published** June 21, 2015

Citation: Saha B (2015) Toxic Metals and Plants. J Plant Biochem Physiol 3: e129. doi:10.4172/2329-9029.1000e129

Cr(VI) is considered to be the more toxic than Cr(III). As an anion Cr(VI) is negatively charged and highly soluble in water and thus has a better bioavailability and is more mobile than the cationic form Cr(III). Cr(VI) can easily cross the cell membranes and the phosphate-sulphatecarrier also transports the chromate anions. Cr toxicity is related to the process of reduction of Cr(VI) to lower oxidation states, not necessarily to Cr(III), in which free radicals are generated. Transient formation of Cr(V) is the most likely mechanism involved in Cr toxicity. Cr(V) complexes are formed from Cr(VI) by physiological reducing agents such as NAD(P)H, $FADH_2$, several pentoses, and glutathione. These complexes react with H_2O_2 to generate significant amounts of •OH radicals with no associated generation of O^{2-}. The •OH radicals may trigger directly DNA alterations as well as other toxic effects. Cr(III) may be sequestered by DNA phosphate groups affecting replication, transcription and causing mutagenesis. Cr affects several processes in plants, namely, seedgermination, growth, yield and also physiological processesas photosynthesis impairment and nutrient and oxidative imbalances.