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ASSESSMENT OF HEAVY METALS TOXICITY ON BIOCHEMICAL & PHYSIOLOGICAL CHANGES IN PULSES

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Abstract

Due to industrialization, accumulation of the heavy metals on the earth has accelerated dramatically. Plants have phytoremediation property through which these elements are taken into the plants which causes the, toxicity into the plants. These metals get stored in all parts of the plant which, triggers lot of physiological and biochemical changes in the plants. Heavy metals contamination has much effect on soil as compared to air and water because heavy metals bind tightly to the surface layers of the soil. Effect of heavy metals also causes reduction in seed germination, vegetative growth, and distortion of root, shoot and leaf tissue structure. Planting crops in that soil contaminated with heavy metals such as Cd, Co, Hg, Cr, As, Mn etc may create significant health risks problems to consumers. In this review we attempted to explore the hazardous effect of heavy metals on productivity of pulses.

Keywords: Chickpea, phytotoxicity, metals, biochemicals, etc.

Introduction

Pulses are important source of dietary protein for a large segment of the world's population, especially in those countries where non-availability or self-imposed restrictions limit the intake of animal protein. Consumption of pulses can have potential health benefits including decreased risk of cardiovascular disease, cancer, obesity, osteoporosis, hypertension, gastrointestinal disorders, adrenal disease and reduction of LDL cholesterol (Tharanathan and Mahadevamma, 2003). These studies resulted in increased interest in research and likely increased use of pulses in daily diet as well as in a variety of food products. Pluses have large edible protein concentrations (18-32%) and provide a major source of essential amino acids and bioactive peptides. Pulse protein has functional properties such as water retention, fat binding, foaming and gelation that can extend its possible use in the production of a number of food products (Rebello et al., 2014).

Heavy metals contamination released from the industry is one of the major concerns in the developing country. Through advances in the process of industrialization, the introduction of toxic effluents into natural resources such as soil, water and air has resulted in the transfer and deposition of these toxic metals into these natural reservoirs. Uncontrolled incorporation of heavy metals to the soil has resulted in major impacts on agriculture and agricultural products. Heavy metals affect the seed germination, growth and production when present in higher concentrations and also associated with the plant physiological and biochemical parameters (Bar et al., 2017). The heavy metals transform into toxins if their concentrations are more than certain limits (Knights., 2004). Although among heavy metals Ni, Cu, and Zn are three key plant micronutrients; which is beneficial for plants however; Cadmium and lead have no known beneficial effects and may become toxic to plants and animals, if their concentrations exceeds from certain limits certain values. (Cheng; 2003). Accumulation of heavy metals has dent

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impact on oxidative damage, membrane alteration, altered sugar and protein metabolisms and nutrient loss (Rehman et al., 2008) and causes the loss of productivity. Chibuike & Obiora (2011) reported that among heavy metals, nickel is more toxic to the plant species affecting the activity of amylase, protease, ribonuclease enzymes, reduced plant height, root length, fresh and dry weight and chlorophyll content thereby decreasing the yield.

Effect of heavy metals on plant growth:

Plants absorb these metals present in the soil solution as soluble components by root exudates (Tang et al., 2006). Plants ability to gather essential metals also acquire some additional non-essential metals into it (Chung 2006). These metals cause various direct and indirect toxic effects into the plants such as cytoplasmic enzyme inhibition and damage to cell structures due to oxidative stress (Thacker et al., 2006). In addition, the effect of heavy metals also affects the microbial load of the soil which alters the productivity of the soil. A decrease in the number of beneficial soil microorganisms due to high concentration of metals may lead to a decrease in decomposition of organic matter leading to a decline in soil nutrients which directly affects the plant metabolism and some important pathway in plants. (Babel and Kurniawan, 2003). Farabegoli, et al., in (2004) reported that soil containing more than 1 mg/kg of Hg significantly decreases the height of rice plants. He also concluded that if the concentration of Cd reaches the 5 mg/L in the soil solution there was a reduction in shooting and root growth in wheat plants. Growth parameters related to the plants attributed to reduce the photosynthetic activity, plant mineral nutrition and reduced enzyme activity (Blaylock and Huang, 2000). In addition, "small" amounts of these metals in the soil can enhance plant growth and development for other metals that are beneficial to plants however;

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reductions in plant growth were observed at higher concentrations of these metals (Djingova and Kuleff, 2000).

The impacts of different heavy metal on plants:

1. Cd results in reduced germination of seeds; decreased nutrient content of plants; decreased shooting and root length of wheat (*Triticum sp*) (Jadia and Fulekar, 2009). Reduced shoot growth; in Garlic (*Allium sativum*) and Reduced shoot growth; inhibition of root growth in Maize (*Zea mays*) (Taiz and E. Zeiger, 2002).
2. Co causes reduction in plant nutrient content in Tomato (Kibra, 2008), reduction in antioxidant enzyme activities; decrease in plant sugar, starch, amino acids, and protein content in Mung bean (*Vigna radiata*) (Kibra, 2008) reduction in shoot length, root length, and total leaf area; decrease in chlorophyll content; reduction in plant nutrient content and antioxidant enzyme activity; decrease in plant sugar, amino acid, and protein content in Radish.
3. Cr causes reduced growth in wheat shooting and root growth (Ahmad et al., 2012) and Inhibition the germination process; reduce the plant biomass in Onion (Kabata-Pendias, 2001).
4. Cu accumulates in plant roots and causes the reduction in the productivity, plant mortality; reduced biomass and seed production (Jayakumar, et al., 2013).
5. Hg induces decrease in plant height; decreased yield; bioaccumulation of seedlings in rice in the shoot and root (Kibra 2008). Reduction in germination; reduced plant height; reduction in flowering and fruit weight ((Jayakumar, et al., 2008).

6. Mn causes shoot and root length reduction (Jayakumar, et al., 2007) decrease in chlorophyll a and carotenoid content; reduction in photosynthetic rate.
7. Ni causes decreased in chlorophyll content and decreased the activity of enzyme activity; decrease in shoot length (Jayakumar, et al., 2007).
8. Pb causes the reduction of germination percentage; suppression of growth; reduction of plant biomass; reduction of plant protein content in maize (*Zea mays*) (Manivasagaperumal et al., 2011) and Inhibition of enzyme activity which affects the CO2 fixation in plants.
9. Zn causes decrease in germination percentage; decrease in plant height and biomass; decrease in chlorophyll, carotenoid, starch and amino acid content (Marin et al., 1993), alteration in structure of chloroplast; reduced plant growth in Pea (*Pisum sativum*) (Abedin et al., 2002).

Discussion:

Continuous effluents of heavy metals cause the contamination of agricultural land which decreases the productivity of lands due to accumulation of these metals. It is also reported in the literature, that when these toxic metals enter into the plants causes the major defects in the plant tissues and alters the activity of enzymes which is involved in the different synthetic pathway. Although, small amount of these metals are necessary for the growth of plants; but when the level of these metals far exceed from the normal value causes the major side effects in plants such as reduction in germination, structure of chloroplast, mineral content , protein content and carbohydrates content and altered pathways of metabolism.

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