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Important Role of Micronutrients: An updated Review

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ABSTRACT: *Micronutrients play an important role in living organism and are essential for the growth. They take part in enzymatic processes and metabolic activities. Thus micronutrients help in the development and are required in appreciate amount of fulfill the needs of the biological systems. The review covers few important elements which can be defined as micronutrients like boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), chlorine (Cl) and the harmful effects of their deficiency on living systems.*

Key words: *Micronutrients, important elements, deficiencies, growth.*

INTRODUCTION

The trace elements are called micronutrients. These are the important nutrients which are essential in minute quantities for the plants growth. These elements are: zinc (Zn), iron (Fe), copper (Cu), manganese (Mn), boron (B), nickel (Ni), molybdenum (Mo), and chlorine (Cl) (Mumtaz et al, 2013). For best growth and development, the 17 elements are essentially required by crop plants. The micronutrients which are required in small quantities for the growth of plant are important nutrients (Farooq et al, 2012). Out of 17, 9 elements are macronutrients while the remaining elements are micronutrients (Asher et al, 1991). The micronutrients such as Na, K, B, Zn, Mn, Mo, Fe, Co and Cu play an important role in soil fertility, physiological and metabolic function in nutrition of plant. Like K and Na are used as stabilizing agent. Zn can act as enzyme. Fe can help in the metabolism and redox reaction of plants. Mn helps in carbon dioxide absorption of nitrogen metabolism (Iqbal et al, 2001). In the growth of waterlogged rice plant, Zn and Fe plays an aggressive role (Das, 2014). Minerals like zinc, selenium and copper play a vital role in the maintenance of skin health. In several metalloenzymes the important cofactor is Zinc. The key role of Zn is to skin protect from photo damaging effect by UV irradiation absorption (Mitchnick et al, 1999).

There is increasing importance in the role of the nutrients in optimising health, and in treatment or prevention of disease (Shenkin, 2006). The significance of micronutrients (such as certain minerals and vitamins) for the health of skin has been highlighted in the cell culture, animal, and clinical study (Park, 2015). Numerous micronutrients are involved as cofactors and coenzymes in enzymatic reaction to transform dietary energy sources, such as fats, carbohydrates and protein into cellular energy such as ATP form (Huskisson et al, 2007). While these micronutrients are important and these micronutrients help in wound healing (Park, 2015). According to the national diet and nutrition survey it is confirmed that suitable consumptions of most micronutrients is necessary (Shenkin, 2006). Nutritional supplementation with micronutrients possesses physiological effect on immune and metabolic functions (Dabhi et al, 2014). Scientists have discovered many elements during the last 30 years and that elements may occur in living organism and these elements are included in the list of essential elements. These elements are As, Br, Cd, Cr, Pb, Li, Mo, Se, Si, Sn, and V. Scientists also have discovered Ni and this element is included in the list of essential micronutrients (Eskew et al, 1984).

The details of micronutrients are given below.

Zinc:

Zn is an essential trace element for all organisms (Bredholt et al, 2016). In natural environment zinc is a common element which play important role in several biological processes. It is a micronutrient essential for normal growth and reproduction of plant, animals and humans. In addition, it plays a key role during physiological growth and accomplishes immune function. Zinc is the part of many enzyme and most of the enzymatic reactions are activated by zinc. Carbonic anhydrase, fructose-1, 6-bisphosphate and aldolase are the enzymes and these are activated by zinc. In plants zinc makes up many complexes with organic acids. (Maleki et al, 2014). Zinc plays an important role in the improvement of human immune system. It is involved in cellular function of living organism. 15 mg Zn per day is needed for adults. Deficiency of zinc may cause serious harmful effects for humans specially. Deficiency of zinc in pregnant women may cause improper development of fetus. Deficiency of zinc in human may cause memory and hair loss, skin problem and weakness in human body. Deficiency of zinc may also cause *acrodermatitis enteropathica* (Maleki et al, 2014). In humans zinc is necessary for the stabilization of DNA, for the gene expression. It also plays an important role in human metabolism. Daily 11mg zinc is needed for men while daily 9mg Zn is needed for female. Daily 3mg Zn is needed for infants (WHO, 2002). Zinc plays an important role in plant metabolism. Plant enzymes are activated by zinc and these enzymes play an important role in protein synthesis, pollen formation and carbohydrate metabolism (Marschner, 1995). Zinc is used in treatment of pneumonia, diarrhoea, common cold, malaria and respiratory infections. Zinc is a important nutrient used for the development of central nervous system:

1. Enzymes dependent on zinc are helpful in brain growth
2. Zinc-finger proteins contribute in neurotransmission and brain structure
3. Neurotransmitters depend on zinc help in brain memory function
4. It is helpful in the precursor production of neurotransmitters
5. Zinc bind in neuron by metallothione in protein (Deshpande et al, 2012).

Iron:

Iron is important to many metabolic functions in the form of heme including the transportation of oxygen in hemoglobin. Furthermore iron is a part of several enzymes, including cytochromes, drug metabolism and energy generation (Dinaz, 2012). On the earth, it is the fourth most abundant element. Less amount of iron is needed by plant that's why it is called micronutrient element. It is the most important element in crops. It is very important for many enzymes. It is main part of the cytochromes. It is also involved in the synthesis of chlorophyll. It is involved in the maintainance of structure of chloroplast (Eskandari, 2011). Iron plays an important role in plant metabolism. It is a critical element for plant growth and it is involved in biological processes such as photosynthesis, chlorophyll synthesis, nitrogen fixation, respiration and DNA synthesis (Kim and Rees, 1992).

Iron is most found in two forms, heme and non-heme (Hurrell and Egli, 2010). Hemoglobin is the main source of iron or we can say that iron is the main component of hemoglobin. While we get non-heme iron from cereals, fruits and vegetables (WHO, 2001). 15% to 35% of heme iron is bioavailable and the effect of dietary factor on its absorption is little while non-heme iron is strongly influenced by other components which are present in food. The amount of non-heme iron in dietary food is greater than the amount of heme iron (Monsen, 1978). If the amount of iron in soil is greater than it may cause toxicity for the plants. Similarly excessive amount of iron in human may cause toxicity it is the main component of cytochromes and cytochromes are involved in electron transport in respiratory chain. (Mengel and Kirkby, 1987).The concentration of iron is reduced due to inhibitors such as phytic acid, polyphenols, calcium and peptides. Enhancers are the ascorbic acid and muscle tissue which may reduce the ferric to ferrous iron and bind it in soluble complex and available for absorption (Hurrell and Egli, 2010). Iron is important for the rapid growth in infants and adolescents. Much amount of iron is required during pregnancy due to rapid growth of placenta and infant (Dallman, 1990)

Manganese:

It is the most important micronutrient essential for the growth of plants and plays an important role in humans and animals. It is the most important component of many enzymes which are involved in photosynthesis and other biological processes. It is a component of antioxidant structure and that antioxidant protects the plant cells against the deactivated free radicals that damage the plant cells (Diedrick, 2010). It plays an important role in the production of chlorophyll. Mn plays an important role in cell division and plant growth. RNA polymerase is a enzyme and it is activated with the help of Mn. It also plays a role in lipid metabolism. Due to deficiency of Mn, the amount of lignin is reduced in plants (lignin is a material that forms the cell wall of plant) (Mousavi et al, 2011). Mn fertilizer increases the yield and quality of crop (Mousavi et al, 2007). It activates many enzymes that are involved in phosphorous reaction, carbohydrates metabolism and citric acid cycle. Large amount of Mn in plants reduces the process of photosynthesis that shows the toxicity for plants growth. Due to higher concentration of Mn in plants, brown spots appear on the leaves of plants (Millaleo et al, 2010).

Copper:

Copper is an important nutrient for humans and an important constituent of several enzymes that control numerous metabolic processes (Lee et al, 2012). Cu plays an important role in living organism including plants, humans and animals. Cu is a metal and is placed in d block in periodic table. It has three oxidation states including Cu^0, Cu^{+1} and Cu^{+2}. Copper is the component of many enzymes. It is also involved in essential redox reactions (Gacheru, 1990).

Boron:

Boron is a micronutrient important for the growth of plant and sexual reproduction. Plant supplies boron but merely lesser quantities are required to provide suitable growth, hence it is categorised as micro nutrient (Jehangir et al, 2017).

Boron is an essential micronutrient for living organism (plants, animals and humans). Boron is an important micronutrient involved in the development and growth of vascular plants, species of marine algal flagellates and diatoms. Fungi, bacteria and green algae don't need the boron. It is involved in nitrogen fixation (Bolanos, 1994). When the level of nitrogen is low is low then we add phosphates, the addition of phosphate decreases the boron deficiency. But when the level of nitrogen is high then we will add phosphates, the addition of phosphate increases the boron deficiency (Beckenback, 1994). It is involved in cell division of plant and it is mostly found in meristematic cells as compared to the mature tissues (Rerkasem, 1996).

Chlorine:

Chlorine is essential micronutrients for plants, animals and humans. It plays an important role in plant's growth. It also plays an important role in the opening and closing of stomata. It is involved in root growth of plants. Stomatal opening is inhibited in the absence of chlorine. It also plays an important role in osmoregulation (Marschner, 1995). Higher concentration of chlorine may cause toxicity to the plants. Its toxicity is associated with the action of nitrate reductase (Berges et al, 1995)

Micronutrient deficiencies

Micronutrient deficiency determination is difficult due to varied symptoms and limited laboratory analysis (Lee, 2012). Nutrition deficiencies, especially insufficient micronutrients are common internationally. Because of poverty and food insecurity, macronutrient and micronutrient deficiency cause diseases which are common in developing countries (Smith and Wimalawansa, 2015). In Pakistan the first micronutrient disorder which was documented in early 1970s is the Zinc (Zn) deficiency as a cause of hadda disease in rice. Subsequently, field-scale deficiencies of iron (Fe), zinc (Zn) and boron (B) have been recognized in many field and agricultural crops. The most extensive deficiency is of Zn as 70 % soils of

Pakistan are Zn deficient which are observed in cotton, rice, sunflower, wheat, maize, brassica, sugarcane, potato and in many other crops along with deciduous and citrus fruits (Imitiaz et al, 2010).The deficiencies of micronutrient are extensive worldwide. World cereal soils are 50% deficient in zinc and 30% of cultured soils worldwide are iron deficient (Das, 2015). According to current reports this deficiency would arise from the pre-operative era, since patients have the intake of carbohydrates in high amount that derived from white rice, refined sugars, oil, fats and oils that are not source of these minerals (Gomes et al, 2013). The most widespread micronutrient deficiency is boron (B) deficiency around the world and causes the large losses in the production of crop both qualitatively and quantitatively. Boron deficiency affects reproductive and vegetative growth of plants causing in inhibition of cell development, reduced fertility and death of meristem (Koshiba et al, 2009). Deficiency of zinc is harmful for plants normal growth. Growth of leaves and plants is stunted due to deficiency of zinc in plants. Deficiency symptoms are stunt growth, short leaves and chlorosis. Plants may be injured by temperature and high intensity of light (Cakmak, 2000). The symptoms of zinc deficiency appear on the young leaves. Deficiency of zinc is also related to weather conditions. In cold weather zinc deficiency is increased that’s why plants root are shorter. The plant shoots cannot uptake zinc if the concentration of bicarbonates is greater in soil (Mousavi et al, 2012). Zn deficiency can reduce numerous functions in the immune system containing peripheral T-cell count, cytotoxic T-cell activity, T-helper cell function, N K cell activity, and macrophage and neutrophil functions (Rink and Gabriel, 2000).In aerobic soil iron is mostly found in the form of trivalent Fe^{+3}.Cell division stops due to deficiency of iron in plants and that’s why leaf growth decreases. By increasing the pH, the solubility of trivalent iron decreases. Due to deficiency of iron chloroplast protein decreases. Due to deficiency of iron plant leaves show yellow color with green vain (Eskandari, 2011). The symptoms of Mn deficiency appear first on the young leaves because Mn is immobilize element .if organic matter is high in soil then there will be deficiency of Mn in soil that’s why the growth of plant will stunt. Small yellow spot will appear on leaves of plants that indicates the deficiency of Mn in plants. Gray-green spot will also appear on the base of leaves that indicates the deficiency of Mn. (Michael and Beckg, 2001). Deficiency of cupper may cause serious effects on living organism. Due to deficiency of cupper the weight of infant is low that’s why the size of liver of infant is smaller. If Infant feed cow’s milk then deficiency of cu in infant body will show because there is not enough amount of cupper in cow’s milk that fulfill the requirement of infant body. Those infant who feed on mother milk will has proper weight because mother milk has enough amount of cupper that fulfill the requirement of infant body and there is no casein in mother milk (Dörner, 1989). Copper deficiencies result in aneurysms, hernias, breakage of blood vessel revealing as hurting or nosebleeds (Araya et al, 2006), anemia iron deficiency (Groff, 1995), abnormalities in glucose and cholesterol metabolism (Roughead and Lukaski, 2003), weakness, fatigue, skin spots, deprived thyroid function , irregular heart beat and body temperature low (Osredkar and Sustar, 2011).

CONCLUSION

Zinc and Iron deficiency in soil and crop plants has been known as a global nutritive constraint. Hence, to conduct large number of controlled experiments to monitor and assess dry land soil and crops genotypes for zinc and iron use efficiency. The repeated method used for zinc and iron use efficiency must be simple and does not involve the analysis of plant. Thus it forms cost effective breeding schemes. For field design nutrient use efficiency and its assessment trials should be normally proved. Development of suitable statistical bundle for complex data analysis Forms such genetical studies. Still, between the soil scientist and breeders a close interaction is deficient which develops a limiting factor and inactive progress. Improving plant micronutrient position in conditions where supply micronutrient nutrition is insufficiently from the soil to increase the yield. This, however, for soil application of higher doses of fertilizer is required due to of low nutrient-use efficiency.

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