Role of Micro-Nutrients and Their Deficiency Symptoms in Rice under Intensive Cropping System

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Introduction

Nutrient is derived from latin word nutrire to 'nourish'. Nutrient is one of the most important factors for plant growth and development. Both macro and micronutrients are necessary for rice plants. Generally, sixteen nutrients are considered important for rice, where N, P and K are the primary macronutrients, Mg, Ca, and S are secondary macronutrients, and Zn, Fe, Mn, Cu, B, Mo and Cl are micronutrients. Every nutrient has its own character in different metabolic processes of plant life. Nutrients affect the disease tolerance or resistance of plants and its deficiency and toxicity conditions inhibit normal plant growth and exhibit characteristic symptoms. For optimal growth, development and production, plants need all the necessary nutrients in balance. Nutrient management both macro and micro nutrient in rice has many benefits to increase soil fertility as well as crop productivity. Micronutrient deficiencies are widespread. 50% of world cereal soils are deficient in zinc and 30% of cultivated soils globally are deficient in iron. Steady growth of crop yields during recent decades (in particular through the green revolution) compounded the problem by progressively depleting soil micronutrient pools. In general, farmers only apply micronutrients when crops show deficiency symptoms, while micronutrient deficiencies decrease yields before symptoms appear.

Rice (*Oryza sativa L.*) is one of the most important staple foods for more than half of the world's population. Its production worldwide is 510.6 million tons (FAO, 2018). Muthayya *et al.*, (2014) observed rice produces up to 50% of the dietary caloric supply for millions of people living in poverty in Asia. It contains reasonable amount of protein (6-10%), carbohydrate (70-80%), mineral (1.2-2.0%) and vitamin (Riboflavin, Thiamine, Niacin and Vitamin E). Now a days, a major factor that affects the food production is the increasing population and to meet the demand in enough quantity without damaging the soil quality, productivity and fertility is becoming biggest challenges in the present agriculture scenario. Therefore, the application of chemical fertilizer (macro and micronutrients) in huge amount are becoming mandatory to achieve the production requirements and also to meet the food demand. But this faulty method not only decreases the soil fertility, but also pollute the environment and also hamper the soil ecosystem and biodiversity. This situation is very prominent in case of rice cultivation area where huge quantity of chemical fertilizers is used. So, to overcome this problem, correct method of applying both macro and micronutrients are very important for rice production. Not only the macro nutrient but proper management of micro nutrients is also equally responsible for better production of rice.

Causes of micro nutrients deficiency in India

- Intensive cropping system through high yielding varieties.

- Lack of organic matter or low or no use of organic matter.
- Use of high analysis fertilizers having no micronutrient content.
- Not using micronutrients.
- Negative interaction of micronutrient with other macro or micro nutrients.
- Unawareness of farmers about micronutrients.
- Soil degradation.

Micro nutrients deficiencies and their Role in rice

Zinc (Zn) : Besides major nutrients, Zn is the most important micro-nutrients particularly in our country because most of Indian soil is deficient of it. Zinc is essential for several biochemical processes such as cytochrome and nucleotide synthesis, enzyme activation, chlorophyll production, maintenance of membrane activity, increase rate of seed and stalk maturation. Zinc deficiencies mainly occur when there is high organic matter in soil, calcareous soils with high bicarbonate content, intensively cropped soils. Paddy soil under prolonged submerged condition cause zinc deficiency. Deficiency symptoms causes brown to dusty brown spots on younger leaves, yellowing of leaves/midrib bleaching. Zinc deficiency in rice soil is commonly known as khaira. The main symptom of khaira in rice is usually in nursery, chlorotic/yellow patches at leaf base on both sides of the midrib; restricted root growth and usually main roots turn brown. But curative measure for correcting are application of 20 - 25 kg/ha $ZnSO_4$ in acid soil, 22 kg Zn/ha initially followed by 5 - 10 kg Zn in the later years or 50% gypsum + 10 t GM + 22 kg Zn once in 2 - 3 years in sodic soils, 1.0 - 1.5 kg/ha Zn as foliar spray at tillering stage and 2 times latter is very helpful for correct this deficiency. Plant Zn uptake from low Zn soils can be increased by Zn mobilizing chemical rhizosphere processes.

Iron (Fe) : Iron plays a vital function in rice photosynthesis. It may hamper K absorption because of its deficiency. The youngest rice leaves show the very first symptoms of its deficiency because of their immobile nature. The initiation of Fe deficiency is identified with interveinal yellowing and chlorosis of developing plants. The advancement of Fe deficiency contributes to a standardized pale yellow appearance with bleached appearances (Snyder and Jones, 1988). Though it is the most difficult and costly micronutrient deficiency to correct it can be controlled by application of $FeSO_4$ 25 kg/ha in between rows, application of iron containing fertilizers or foliar spary of $FeSO_4$ 1% - 3% solution. Iron toxicity is caused by toxic effects of excessive Fe uptake due to large concentration of Fe in soil solution

Boron : Boron is also one of the most important micro nutrient which is essential for cell wall formation, development of new cells in meristematic tissue, translocation of sugars, starches, phosphorus etc., and also concerned with precipitating excess cations, buffer action, regulatory effect on other nutrient elements etc. Boron deficiency occurs under moister stress and dry condition which cause reduced plant height (Zu *et al*., 2012). Plants fail to produce panicles if they are affected by B deficiency at the panicle formation stage. The tips of emerging leaves are white and rolled. Okuda *et al*., (1961) observed B deficient rice plant panicles certainly did not allow them to come out of the boot and eventually decreased grain production. For the corrective measure's application of B (1 - 2 kg/ha) is superior to foliar sprays. For hidden deficienct, spary 0.2% boric acid or borax at pre flowering or flower head formation stages. Excess of boron appears to inhibit the formation of starch from sugars or results in the formation of B-carbohydrate complexes, resulting in retarded grain formation (Chaudhary *et al*., 1976).

Manganese (Mn): Manganese also plays an important role in rice as it influences auxin levels in plants and high concentrations

of Mn helps in breakdown of Indole Acetic Acid (IAA), takes part in electron transport in photosystem II. Manganese also supports the movement of iron in the plant. Manganese deficiency is very common in upland rice, Pale greyish green interveinal chlorosis spreads from the tip to the leaf base. Necrotic brown spots develop later and leaf becomes dark brown. Newly emerging leaves become short, narrow and light green. Deficient plants shorter, with fewer leaves, weigh less, and smaller root system at tillering. Manganese deficiency can be corrected by application of farmyard manure, acid forming fertilizer (do not use urea), $MnSO_4$ or MnO at 2 - 5 kg/ha as multiple application (Chaudhary *et al*., 1976). Chelates should be avoided as Fe and Cu displaces Mn.

Silicon (Si): Silicon is the second most abundant element in the soil after oxygen but not yet classified as an essential nutrient. Although Si is abundant in the earth's crust, its availability in soil is very low because of its low solubility from soil source (Lindsay. 1979). Silicon also provides greater stalk strength and resistance to lodging, increased availability of phosphorus, reduced transpiration etc. Silicon tends to maintain erectness of rice leaves, increases photosynthesis because of better light interception. The major deficiency symptoms of Si in rice are soft droopy leaves and culms, lodging of plant, severe pest-disease attack (Johnson *et al*., 2005). Deficiency generally occurs due to small mineral reserves in organic soil, old paddy soils of subtropical and temperate climates. Silicon deficiency can be correct by irrigation of water rich in Si, avoid excessive application of N fertilizers, recycling rice hulls or hull ash, apply granular silicate fertilizers like Ca. Silicate: 120 - 200 kg/ha; K silicate: 40 - 60 kg/ha for rapid correction. Foliar spray of Si at 0.1% - 0.2% with sodium silicate improve Si nutrition.

Copper (Cu): Copper helps in the utilization of iron during chlorophyll synthesis. Lack of copper causes iron to accumulate in the nodes of plants. It has an unique involvement in enzyme systems of plants like oxidase enzymes, terminal oxidation by cytochrome oxidase, photosynthetic electron transport mediated by plastocyanin etc. It also acts as "electron carrier" in enzymes which bring about oxidation-reduction reactions in plants. Sandy, calcareous, lateritic soil, high in organic matter induce Cu deficiency in soil. The main important deficiency symptoms of copper are chlorotic leaves, bluish green leaves, new leaves don't unroll and leaf tips give needle like appearance, reduced tillering, less pollen viability. Excessive liming in acid soil sometimes causes Cu deficiency in soil (Rafique *et al*., 2002). It can be control by seeding root dipping in 1% $CuSO_4$ suspension, apply Cu at 5 - 10 kg/ha once in 5 years in the form of CuO or $CuSO_4$. Foliar application can be done during tillering to panicle initiation stage. Soil application can also be done with $CuSO_4$ as broadcasting or band placement.

Molybdenum (Mo): Molybdenum is an essential component of the major enzyme nitrate reductase in plants. Its requirement of plants is influenced by the form of inorganic nitrogen supplied to plants, with either nitrite (2 NO^-) or ammonium (4 NH^+) effectively lowering its need. It is also reported to have an essential role in iron absorption and translocation in plants. Deficiency symptoms of Mo in rice resembles to nitrogen deficiency (older leaves become chlorotic). Necrotic spots are seen at leaf margins because of NO_3 accumulation. Molybdenum deficiency can be correct by liming of acid soils to pH 6.5 (not preferable if pH change is not desirable for other purposes). Beside these dusting with Na/NH_4 at 100 - 500 g/ha is very much beneficial. Foliar spay of Na/NH_4 molybdate at 0.1% is also beneficial (Graham *et al*., 2002).

Conclusion

Micronutrients play an important role in crop production. They are equally importantilike macronutrients so their application is necessary.

There is very narrow difference between deficiency and toxicity levels, so, micronutrients should be applied carefully only when crop needs them and after soiltest.

There is need for application of mixed and complex frertilizers containing micronutrients.

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