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A Review on role of Zinc in Rice Yield and Growth

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Abstract

Zinc is an important micronutrient for rice in respect of their growth and development. The deficiency of Zinc is very common in Indian soils. As a major nutrient Nitrogen and phosphorus the zinc plays an important role in rice crop production. The yield and yield attributing characters of rice may be improved by the application of zinc in soil. The application of Zinc in soil for the production of rice either by organic sources or inorganic sources or integrated way improves the grain quality, productivity of rice and fertility status of soil. The concentration and correction of deficiency symptoms can done by application of Zinc in soil either by foliar application or direct soil application. Rice grown in low land areas found severe deficiency of Zinc and it can by enhanced by improving organic matter content and soil pH. The several experiments were conducted to improve the rice yield by the application of Zinc in soil. This research paper has been reviewed for improvement in Zinc concentration in soil for better rice growth and yield.

Introduction

Zinc is most deficient micronutrient in soils worldwide and considered as a major threat to the global and regional food security (Cakmak 2002, Rana & Kashif 2014). More than 30% soils in the world are suffering from deficiency of Zinc availability (Alloway 2008). Tiong *et al*. 2014 reported that in high rice consuming fields, Zinc deficiency reduced the yield and Zinc malnutrition in human beings. Zinc play an important trole in crop production because of it is an essential component of many enzymes and controls various biochemical processes in plants for growth (IARI 2000). Zinc is a essential micronutrient for all living organisms including human beings (Broadley *et al*. 2007). Roughly one third of the global population is suffering from deficiency of Zinc and does not ingest adequate amounts zinc (Brown *et al.* 2004, Galetti 2008).

Soils having high pH appear to be main factor for the widespread of Zinc deficiency in calcareous soils of Indo - Gangetic plains of India (Qadar 2002). Rice is a staple food and main source of energy for more than half of the universe population. It is an edible food belongs to the family Poaceae. Along with major nutrients, management of Zinc fertilization in rice crop has positive impact on rice yield and also increase the Zinc content in rice grain helps in minimizing Zinc deficiency; which rank fifth among the most important health risk factor in developing countries and eleventh in world (Vasu 2024). This review paper has been analysed on the basis of roles of Zinc, impact of Zinc of growth, yield and yield attributing characters of rice, method and source of Zinc application to control Zinc deficiency in rice crop.

Roles of Zinc in rice

Zinc is major component of several enzymes involved in crucial metabolic pathways, carbohydrate and protein metabolism. It is necessary for the production of chlorophyll which is important in photosynthesis and directly related to growth and yield of rice. Zinc involved in synthesis and regulation of various enzymes in plant which influence the growth and development of rice plant. The grain quality of rice improved by application of zinc. It reduces the various type of stresses by including nutrient deficiencies, submerged condition

and sodicity. Zinc content in rice grains helps in resolve Zinc deficiency in human beings.

Zinc deficiency can reduce the yield growth, quality of grain in rice.

Imitiaz *et al.* (2019) reported that deficiency of zinc in rice have a negative impact on crop productivity and grain quality because of various diseases and physiological disorders. "Khaira disease" is very common disorder in rice arises from deficiency zinc. DNA replication and hormone regulation emphasizes its essential nature for the growth and development of rice. Growth hormone ayxin is affected by deficiency of zinc. It causes little leaf syndrome, stunted growth and shoot elongation.

Effect of Zinc on growth of rice

A field experiment was conducted in Jammu and Kashmir on rice and reported that a significant response was observed to zinc application up to 6 Kg per ha in respect to growth parameters like plant height, leaf area index (LAI), dry matter accumulation and number of tillers/hills (Talib *et al*. 2016). It was observed that foliar application of 0.5% ZnSO4 (panicle initiation + 1 week after flowering) increased the maximum plant height in rice crop (Shikh *et.al*. 2022).

Increased number of tillers and plant height with increasing levels of ZnSO4 as soil application proved better to its foliar nutrition (Panda & Nayak 1974). Singh & Shivay (2013) also reported that residual effect of Chelated Zinc (Zn-EDTA) was found best with respect to growth, yield attributes and yield of rice. Sisodiya *et al*. (2021) also reported that rice variety and level of Zinc application significantly influenced the growth, yield components and yield of rice.

Effect of zinc on yield components, yield and quality of rice

The several field experiments were conducted to evaluate application of Zinc in rice crop and concluded that rice crop responded positively in respect growth, yield components, yield and quality of rice. It is obivious from the data under zinc deficient condition crops are respond more to application of zinc. The rice grain and straw yield of rice increased significantly due to application 10 mg/kg zinc in deficient category by 56.6% and 13.8%, respectively. The rice varieties and levels of zinc application significantly improved the growth, yield components and yield of wheat by the application of ZnSO4 @ 25 kg ha-1 or foliar application of 0.75%. ZnSO4 after 30 and 60 days after transplanting (Sisodiya *et al*. 2021). Application of zinc in significant quantities and appropriate time produced optimum rice yield because rice yield may be decreased by 25-50% under zinc deficiency (Sobky *et al*. 2022).

It was observed that foliar spray of Znso4iseffective in correcting zinc deficiency and also improved zinc content in rice grain (Stomph *et al*. 2011). The significant improvement in grain and straw yield of rice and zinc concentration in rice grain were observed with foliar application of Zn as Zn-EDTA and ZnSO4, while highest improvement was recorded with Zn-EDTA (Chelated Zinc) application (Karak & Das 2006). In low land rice areas application of Zinc before transplanting proved better than foliar application of 0.5% W/V ZnSO4 (Savithri *et al.* 1998). Application of organic manure in rice fields improves the micronutrient availability by changing the physical, chemical and biological properties of soil. In submerged rice fields application of *Azolla* as a green manure prevented zinc deficiency (Mandal et al. 2019). The application of zinc @ 20 kg per hectare as basal and foliar application found to have positive and significant effect on grain yield and uptake of zinc (Chhabra & Kumar 2018).

Methods of Application and Sources of zinc in rice

Application methods and zinc fertilization (sources of zinc) enhance the zinc uptake by rice plant. The many methods are popular among the farmers to zinc application like soil application and treatment, foliar nutrition (Johnson et al. 2005). Continuous flooding in rice crop reduced zinc efficiency due to formation of insoluble Zinc and zinc franklinite ($ZnFe_2O_4$) Ponnamperuma 1972). The zinc is commonly applied in low land areas for the production of rice before flooding or after transplanting to prevent zinc deficiency (Naik & Das 2007). Sources of zinc as $ZnSO_4$ better than zinc reported by Shivay *et al*. (2008). $ZnSO_4$ > Zn-EDTA > metallic zinc > fritted zinc improved the dry matter yield and zinc uptake and yield of crop (Kang &

Okoro 1976). Selection of appropriate zinc sources and methods of application can improve the uptake of zinc under submerged condition.

Conclusion

Low plant availability of soil zinc is a critical problem for rice crop production, causing acute reduction in nutritional quality in grain and yield of rice . However, on the basis of analysis of data it was concluded that deficiency of Zinc can be corrected by application Zinc sulphate, Zn-EDTA, & either through soil application, foliar application and seedlings treatment. The application of zinc in deficient soil and submerged soils of rice field may be boost rice production and also nutritional quality in rice grain. Application of Zinc through organic source may be helpful in rice production and properties of soil. The higher zinc content in rice grain improves the nutritional quality in grain which may be solve the deficiency of zinc in human beings.

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