Environment and Ecology 42 (2A) : 606—609, April—June 2024
Article DOI: https://doi.org/10.60151/envec/LLAQ8000
ISSN 0970-0420

# Response of Zinc in *Kharif* Rice cv MTU-1010

**Pabitra Adhikary, Mrinal Kanti Das, Ankush Sarkar, Sukanta Saren, Babulal Tudu**

Received 26 May 2023, Accepted 1 March 2024, Published on 6 May 2024

## ABSTRACT

A filed experiment was conducted during *kharif* season of 2016 and 2017 at Krishi Vigyan Kendra (KVK) Farm, Ashokenagar, West Bengal on a sandy loam soil to assess the effect of zinc on growth, yield attributing characters and yield of rice, cv MTU- 1010. The experiment was carried out in a Randomized Block Design with three treatments i.e. recommended NPK dose (60:30:30 kg/ha NPK), recommended NPK + 25 kg/ha of $ZnSO_4$ as soil application, and recommended NPK + 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 and 45 DAT with seven replications. The study revealed that most of the yield and yield attributing characters except a few were significantly influenced by the soil and foliar application of zinc. Application of zinc recorded 17.73% higher grain yield than soil application of sole NPK fertilizers. The maximum no. of effective tillers/hill (23.57), plant height (81.28 cm), no. of spikelet per panicle (89.57), yield (5.91 t/ha), starch content (75.28 %) and B:C ratio (1.87) were recorded in 20 kg/ha of $ZnSO_4$ as soil application followed by 2.5 kg/ha as foliar application at 30 and 45 DAT, along with soil application of NPK.

**Keywords** Rice, Zinc, Growth parameters, Yield.

## INTRODUCTION

Rice is highly sensitive to zinc deficiency and zinc is the most important micronutrient limiting rice growth and yield. Zinc deficiency in rice has been found in lowland rice of India (Sudha and Stalin 2015). Zinc is essential for several biochemical processes in the rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation, membrane integrity (IRRI 2000) and respiration. Zinc deficient rice plants show poor ability of root respiration especially under flooded rice soils. Zinc deficiency in plant is noticed when the supply of zinc to the rice plant is inadequate. Though rice plants need a little quantity of zinc but its concentration is critical and if it is not available in the adequate quantity plants suffer from physiological stress (Tiong *et al.* 2014). Zinc deficiency is prevalent worldwide in temperate and tropical climates. The availability of Zn in the soil varies widely depending on the soil properties. Zinc contents in soil and leaves of rice were directly related to the increased application of this element. Application of zinc salts in the form of zinc sulfate is a common practice to correct Zn deficiency. Zinc fertilizer can be applied as ground fertilizer, root dipping, seed socking, seed dressing

Pabitra Adhikary[1]*, Mrinal Kanti Das[2], Ankush Sarkar[3], Sukanta Saren[4], Babulal Tudu[5]

[1] Subject Matter Specialist (Agronomy)
[2] Subject Matter Specialist (Agro-meteorology)
[3]Senior Research Fellow
[4] Farm Manager, [5]Senior Scientist and Head
[1, 2, 3, 4, 5]North 24 Parganas Krishi Vigyan Kendra, West Bengal University of Animal and Fishery Sciences, Ashokenagar 743223, West Bengal, India

Email : pabitra.bdp@gmail.com
*Corresponding author

and top dressing and or either foliar spray. Efficient uptake and transport of micronutrients to the grains can be increased by foliar application of micronutrient containing fertilizers (Kulhare *et al.* 2016). Therefore, like other micronutrients, foliar application of Zn is considered as potential method to ameliorate Zn deficiency in cereal grains. In view of the role of micronutrients in present day agriculture, the study was therefore, conducted to evaluate the response of a rice cv MTU - 1010 to different zinc doses grown in alluvial soils under rainfed condition.

## MATERIALS AND METHODS

Field experiment was carried out at the Instructional Farm, Krishi Vigyan Kendra, Ashokenagar, North 24 Parganas, West Bengal during two successive *kharif* seasons of 2016 and 2017 to study the effect of zinc on growth, yield attributing characters and yield of rice, cv MTU-1010. The experiment consisted of three treatments i.e. Recommended NPK dose (60:30:30 kg/ha NPK), Recommended NPK + 25 kg/ha of $ZnSO_4$ as soil application, and Recommended NPK + 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 and 45 DAT. The sources of N, P, K and Zn were urea, single super phosphate, muriatic of potash and $ZnSO_4$. The experiment was laid out in a Randomized Block Design with seven replications. Intercultural operations like irrigation, weeding, insect pest control were done whenever required. The crop was harvested at 135 days after transplantation at full maturity. Plot-wise yield and yield attributes were recorded. Samples were analyzed physically and chemically following the standard procedures. The data were subjected to statistical analysis by analysis of variance method. The correlation studies were made to reveal the association among the variables in the investigation (Gomez and Gomez 1984). As the error mean squares of the individual experiments were homogenous, combined analysis over the years were done through un-weighted analysis. Here, the interaction between years and treatments were not significant.

## RESULTS AND DISCUSSION

Number of tillers is one of the most critical yield contributing components. More the number of fertile tillers better will be the crop stand, which ultimately would increase the yield. There was an increase in the tillers with an increase in the zinc levels. It is evident (Table 1) that the highest number of effective tillers (23.57 per hill) was recorded where 20 kg/ha of $ZnSO_4$ as soil application followed by two times foliar application @ 2.5 kg/ha at 30 DAT and 45 DAT along with recommended NPK. Whereas, significantly the lowest number of tillers (20.85 per hill) was counted from the control plot having no Zn application. This is due to addition of Zn decreased the inter venal chlorosis and necrosis of rice seedlings and enhanced the number of tillers per plant and also the increase in tillering might be attributed to improved enzymatic activity and auxin metabolism in plants by zinc. These results are similar to that of Muhammad *et al.* (2015). The data regarding the plant height as influenced by zinc application (Table 1) and the zinc treatments increased the plant height significantly over only sole application of NPK. The maximum plant height (81.28 cm) was recorded in the treatment receiving recommended dose of NPK along with 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT which was significantly different from all other treatments. Minimum plant height (68.57 cm) was recorded in only NPK treated plots. This might be attributed to the adequate supply of zinc which contributed to accelerate the enzymatic activity in plants. These results find support from the findings of Firdous *et al*. (2018) who noted an increase in the rice plant height with the application of $ZnSO_4$. The results showed that all the applied doses of zinc fertilizer increased significantly the number of panicle per plant over control. The maximum number of 19.57 panicles per plant was recorded in the treatment receiving 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT which was statistically at par with the treatment receiving 25 kg/ha of $ZnSO_4$ as soil application. The increase in panicles per plant might be ascribed to adequate supply of zinc that might have increased the availability and uptake of other essential nutrients and thereby resulting in the improvement of crop growth. The results support the findings of Firdous *et al*. (2018) who reported that adequate supply of Zn results in greater number of panicles per plant. The panicle length was also influenced by zinc application. Maximum 27.57 cm

**Table 1.** Effect of zinc on growth of *kharif* rice.

| Treatment | No. of effective tillers/hill | Plant height (cm) | No. of panicle per plant | Panicle length (cm) | No. of spikelet per panicle | Grain length (mm) | Grain breadth (mm) | Grain length breadth ratio |
|---|---|---|---|---|---|---|---|---|
| Recommended NPK dose (60:30:30 kg/ha NPK) | 20.85 | 68.57 | 12.14 | 24.42 | 86.14 | 8.52 | 2.94 | 2.89 |
| Recommended NPK + 25 kg/ha of $ZnSO_4$ as soil application | 22.85 | 75.85 | 16.42 | 26.45 | 87.85 | 8.74 | 2.82 | 3.09 |
| Recommended NPK + 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 and 45 DAT | 23.57 | 81.28 | 19.57 | 27.57 | 89.57 | 8.90 | 2.87 | 3.10 |
| $LSD_{0.05}$ | 1.990 | 2.360 | 1.862 | 0.915 | NS | NS | NS | - |

length was recorded in the treatment recommended dose of 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT and the minimum (24.42 cm) was in no zinc plots. Our results get support from the investigations of Muhammad *et al.* (2015) who found that application of zinc sulfate significantly produced more panicle length than the control. The data regarding the number of spikelet per panicle as affected by various doses of zinc fertilizer (Table 1) which indicated that all the applied doses of zinc increased the number of spikelet panicle significantly over control. The maximum number of 89.57 spikelet per panicle was recorded in the treatment receiving recommended dose of 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT. Minimum number of 86.14 spikelet per panicle was recorded in the treatment receiving recommended dose of 60:30:30 NPK. The increase in number of spikelet due to zinc fertilizer might be due to its effect on enhancing the physiological functions of the crop, like photosynthesis and translocation of plant nutrients which ultimately increased the number of spikelet per panicle. The results are also supported by the findings of Firdous *et al*. (2018). The highest length and length-breadth ratio of rice grain was recorded where recommended dose of 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application followed by 2.5 kg/ha as foliar application at 30 DAT and 45 DAT (Table 1). On the contrary, the highest breadth was found in the treatment receiving recommended dose of 60:30:30 NPK and lowest in 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT. The results are also supported by the findings of Ali *et al.* (2014).

It is evident from the Table 2 that all the doses of zinc fertilizer increased the 1000-grain weight over control. The maximum 1000-grain weight of 23.82 g was recorded in treatment receiving 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT. While

**Table 2.** Effect of zinc on yield and economics of *kharif* rice.

| Treatment | 1000 – grain weight (g) | Yield (t/ha) | Starch content (%) | Protein content (%) | Cost of cultivation (Rs/ha) | Gross return (Rs/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| Recommended NPK dose (60:30:30 kg/ha NPK) | 21.42 | 5.02 | 71.85 | 6.93 | 30500.00 | 54285.00 | 1.77 |
| Recommended NPK + 25 kg/ha of $ZnSO_4$ as soil application | 22.92 | 5.75 | 73.71 | 7.28 | 31200.00 | 57500.00 | 1.84 |
| Recommended NPK + 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 and 45 DAT | 23.82 | 5.91 | 75.28 | 7.71 | 31500.00 | 59142..00 | 1.87 |
| $LSD_{0.05}$ | 0.960 | 0.303 | 1.645 | 0.412 | - | - | - |

the minimum 1000- grain weight of 21.42 g was recorded in the treatment receiving 60:30:30 NPK. The comparative increase in 1000- grain weight with the application of zinc might be due to more efficient participation of Zn in various metabolic processes involved in the production of healthy seeds. Many research workers have reported about the improvement in 1000-grain weight by the application of zinc. Likewise Rana and Kashif (2014) observed that the application of NPK along with other micronutrients like zinc increased test weight sharply over control. All the zinc treatments applied, increased the rice yield significantly over control. Although the highest rice yield of 5.91 t/ha was recorded in the treatment receiving 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT and significantly differ from the other treatment. Minimum rice yield of 5.02 t/ha was recorded in control which might be due to the non availability of zinc while the higher rice yield due to zinc application might be due to the combined effect of many yield components, like number of tillers, number of panicles, 1000-grain weight. Guo *et al.* (2016) and Chhabra and Kumar (2018) also reported similar results. The data presented in Table 2 showed that protein content in rice grain was not significantly influenced by the application of different levels of Zn whereas starch content significantly varied with the treatments. Chlorophyll contents and net photosynthetic rates were significantly decreased and protein synthesis of rice was prevented due to Zn deficiency and also observed that rice quality increased by Zn application. The protein content varied from 6.93 % to 7.71% in grain and starch content varied from 71.85 % to 75.28%. Our present study has produced the same result as that reported by Jatav and Singh (2018). Data in Table 2 showed that application of zinc at different intervals significantly enhances the net returns and B:C ratio. The higher B:C ratio (1.87) with the application of recommended dose of 60:30:30 NPK+ 20 kg/ha of $ZnSO_4$ as soil application + 2.5 kg/ha as foliar application at 30 DAT and 45 DAT might be due to higher net returns obtained by the treatment.

Treating the soil with Zn fertilizer as well as foliar application has been found to enrich it with utilizable plant nutrients associated with enhanced yield of rice crop. It can be concluded from these results that amending the soil with Zn fertilizer @ 20 kg/ha as soil application followed by 2.5 kg/ ha as foliar application at 30 DAT and 45 DAT was found the most appropriate dose for higher yield of rice crop in alluvial soil of West Bengal.

## REFERENCES


Ali H, Hasnain Z, Ahmad NS, Sarwar N, Qureshi MK, Khaliq S, Qayyum M (2014) Nitrogen and zinc interaction improves yield and quality of submerged Basmati rice (*Oryza sativa* L.). *Not Bot Horti Agrobio* 42 (2) : 372—379.

Chhabra V, Kumar R (2018) Role of zinc application on rice growth and yield. *Plant Arc* 18 (2) : 1382—1384.

Firdous S, Agarwal BK, Shahi DK, Bhushan S (2018) The effect of zinc fertilization on rice productivity and economics in acid alfisol of Jharkhand, India. *Int J Curr Microbio App Sci* 7: 2676—2682.

Gomez KA, Gomez AA (1984) Statistical procedures for agriculture research. *Int Rice Res Inst.* Jhon wiley and sons. New york, pp 139—240.

Guo JX, Feng XM, Hu XY, Tian GL, Ling N, Wang JH, Shen QR, Guo SW (2016) Effects of soil zinc availability, nitrogen fertilizer rate and zinc fertilizer application method on zinc biofortification of rice. *The J Agril Sci* 54 (4) : 584—597.

IRRI (2000) Nutritional disorders and nutrient management in rice. Inter. *Rice Res Ins Manila Philippines.*

Jatav SS, Singh SK (2018) Evaluation of different methods of zinc application on growth and yield of hybrid rice (*Oryza sativa* L.) in inceptisol of Varanasi. *J Pharma Phyto* 7 (4) : 1739—1744.

Kulhare PS, Tagore GS, Sharma GD (2016) Effect of zinc fertilization on yield and zinc uptake efficiency of rice genotypes grown in central India. *Int J Agri Sci* 8 (2) : 964—967.

Muhammad N, Iqbal N, Muhammad US, Mirza MA (2015) Effect of $ZnSO_4$ mixed with different fertilizers on paddy yield of fine grain rice. *App Sci Bus Econ* 2 (1) : 8—12.

Rana WK, Kashif SR (2014) Effect of different zinc sources and methods of application on rice yield and nutrients concentration in rice grain and straw. *J Env Agril Sci* 1 : 2—9.

Sudha S, Stalin P (2015) Effect of zinc on yield, quality and grain zinc content of rice genotypes. *Int J Farm Sci* 5 (3) : 17—27.

Tiong J, McDonald GK, Genc Y (2014) HvZIP7 mediates zinc accumulation in barley (*Hordeum vulgare*) at moderately high zinc supply. *New Phyto* 201 (1) : 131—143.