JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

IMPACT OF MICRONUTRIENTS ON YIELD ATTRIBUTES AND YIELD AS FOLIAR APPLICATION IN RICE

S. Gunalan[1], *S. Elankavi[2] and P. Sudhakar[2]

[1]Department of Agronomy, Annamalai University, Chidambaram-608602.

[2]Associate Professor, Department of Agronomy, Annamalai University, Chidambaram-608602.

***Corresponding author: -**

S. Elankavi, email: ekavi76@gmail.com. contact: 7010041656.

ABSTRACT

The current study, Impact of micronutrients on yield attributes and yield as foliar application in rice, was conducted at the Experimental Farm Department of Agronomy, Annamalai University, Tamil Nadu, India, during the Samba Season (September, 2022 - February, 2023). The eight treatments comprised of different nutrient management practices viz., 100 % RDF (T_1), 100 % RDF + foliar application of $ZnSO_4$ @ 0.5 % (T_2), 100 % RDF + foliar application of Borax @ 0.25 % (T_3), 100 % RDF + foliar application of Silicon @ 1 % (T_4), 100 % RDF + foliar application of $ZnSO_4$ @ 0.5 % + Borax @ 0.25 % (T_5), 100% RDF + foliar application of ZnSO4 @ 0.5 % + Silicon @ 1% (T_6), 100 % RDF + foliar application of Borax @ 0.25 % + Silicon @ 1 % (T_7) and 100 % RDF + foliar application of $ZnSO_4$ @ 0.5 % + Borax @ 0.25 % + Silicon @ 1 % (T_8). The results showed that transplanted rice benefited from the foliar application of micronutrients such as silicon, zinc, and borax. Characteristics of yield include number of panicles m^{-2}, length of panicle (cm), and number of filled panicles $^{-1}$.

KEYWORDS : Rice, Foliar application, $ZnSO_4$, Borax, Silicon

INTRODUCTION

The total area under cultivation for rice is 166.91 million hectares, and the yield is approximately 514.6 million tonnes, with a productivity of 4.60 t ha^{-1}. Worldwide rice productivity is 4.41 t ha^{-1} in South East Asia (USDA, 2022). After China, India is the world's second-biggest producer and consumer of rice. A total of 46.38 million hectares are used to grow rice in India, yielding an annual production of 130.29 million tonnes and a productivity of 2.80 t ha^{-1}. Over the past few years, it has been observed that rice yield is declining, with nutritional imbalance being identified as a major cause for concern. Achieving food security is threatened by the world's population growth, but nutrient management, which raises rice productivity and production, may be a promising solution.

Micronutrients are required in trace amounts, but a sufficient supply enhances nutrient availability and has a positive impact on cell physiology, both of which are reflected in yield. Due to heavy cropping, the loss of rich topsoil, and nutrient leaching, micronutrient-deficient soils are remarkably commonplace throughout the world. Micronutrient deficiencies in 50% of the world's soils and many crops significantly lower food production and quality, which has a negative impact on global environmental quality, farmer livelihood, and human health (Siddika *et al*., 2016). Foliar application of nutrients, which greatly increases rice yield, growth, and other yield attributes (Saikh *et al*., 2022). Therefore, for plants grown in low-nutrient soil or under stress, especially in arid and semi-arid environments, supplemental foliar nutrient application is the most effective technique (Soltani *et al*., 2022).

The application of zinc fertilizers is necessary to maintain adequate transport of zinc to seeds, a sufficient amount of available zinc in soil solution, and gains in crop yield. B contributes to the enhancement of total chlorophyll content and plant height, and its main functions are cell wall biosynthesis and the structure and integrity of the plasma membrane (Songsriin *et al*., 2023). The addition of silicon made rice leaves more erect, which enhances photosynthetic efficiency, drought resistance, and light interception. Additionally, it increases rice plants resistance to both biotic and abiotic stresses. For this reason, managing silicon is crucial to raising and maintaining rice productivity (Singh *et al*., 2020). The goal of the current study was to examine how foliar nutrient application affects rice transplants.

MATERIALS AND METHODS

During the Samba season (September, 2022 - February, 2023), the current study was carried out at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University. The experimental farm is situated at +5.79 meters above mean sea level at latitude 11°24' N and longitude 79°44' E. Conditions are hot and the temperature is moderately warm. A mean of 25 °C is found for the maximum temperature during the crop-growing period, which varies from 28.4 to 35.4 °C, and a mean of 21.5 °C is found for the minimum temperature. A mean of 79.6 % is found in the relative humidity, which ranges from 68 to 91 %. 50 rainy days translated into 1223.8 mm of total rainfall during the cropping period. The experimental field's soil type was clay loam, with low levels of available nitrogen, medium levels of available phosphorus, and high levels of available potassium. BPT 5204, a medium-duration rice variety, is chosen for this investigation. The research comprised of eight treatments arranged in three replications under a randomized block design (RBD): 100% RDF (T_1), 100% RDF + foliar application of $ZnSO_4$ @ 0.5% (T_2), 100% RDF + foliar application of Borax @ 0.25% (T_3), 100% RDF + foliar application of Silicon @ 1% (T_4), 100% RDF + foliar application of $ZnSO_4$ @ 0.5 % + Borax @ 0.25 % (T_5), 100% RDF + foliar application of $ZnSO_4$ @ 0.5 % + Silicon @ 1% (T_6), 100% RDF + foliar application of Borax @ 0.25% + Silicon @ 1% (T_7), 100% RDF + foliar application of $ZnSO_4$ @ % + Borax @ 0.25 % + Silicon @ 1% (T_8).

A fertilizer schedule consisting of 50 kg P_2O_5, 50 kg K_2O, and 150 kg N fertilizer was applied according to the schedule. As basal, the full dosage of phosphorus and half of the doses of nitrogen and potassium were applied. At the peak tillering and panicle initiation stages, the remaining half of the potassium and nitrogen dose was top dressed in equal splits. Applying $ZnSO_4$ at 2.5 kg ha^{-1}, Borax at 1.25 kg ha^{-1}, and Silicon at 5 kg ha^{-1} via foliar spray at 25 and 45 DAT with a 500 lit ha^{-1} spray volume using a hand-operated backpack sprayer was carried out in accordance with the treatment schedule. For periodic observations, five representative plants were randomly chosen from each treatment plot and pegged. From these plants, data on growth and yield parameters were collected. As recommended by Gomez and Gomez (1984), statistical analysis was performed on the data pertaining to the various characters that were examined throughout the investigation. To draw statistical conclusions, the critical difference was calculated at the 5 percent probability level for significant results.

RESULTS AND DISCUSSION

The foliar application of nutrients had a significant impact on the yield attributes. Table 1 displays the present data.

The treatment application of 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% + Silicon @ 1% (T_8) significantly recorded the highest number of panicles of 325 m^{-2} among the treatments. Then, with a value of 310 m^{-2}, 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Silicon @ 1% (T_7) was applied. This is statistically comparable to 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% (T_5). T_1(control) had the fewest panicles, measuring 263 m^{-2}. The treatment with the highest maximum panicle length of 26.10 cm was 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% + Silicon @ 1% (T_8). A panicle length of 24.20 cm, which is statistically comparable to 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% (T_5), was applied after that. This was done with 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% + Silicon @ 1% (T_7). At the maturity stages, T_1 (control) registered the lowest value of 19.20 cm. The treatment consisting of 100 % RDF + $ZnSO_4$ @ 0.5% + Borax @ 0.25% + Silicon @ 1% registered the highest number of filled grains $panicle^{-1}$ among the treatments, with a total of 90.89 (T_8). Following this was 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% + Silicon @ 1% (T_7), yielding an 87.52 percentile, which is comparable to 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% (T_5). The least amount of (73.75) filled grains $panicle^{-1}$ was recorded in the control treatment (T_1). The greatest number of productive tillers per m^{-2} and the length of the panicle may be the result of the efficient use of NPK and micronutrients; N promotes better nutrient absorption, which leads to faster growth of the foliage and better accumulation of photosynthates, which in turn leads to increased growth structure. Singh *et al*. (2005) presented similar findings. The accumulation of assimilates, which in turn facilitates higher N assimilation with an adequate supply of photosynthates to grain, is the primary mechanism by which major nutrients, especially N, affect yield attributes. This may be due to the fact that more nutrients were available during the reproductive stage, causing panicles to absorb more carbohydrates and produce more $panicle^{-1}$ grains in rice. These outcomes were consistent with findings Hartatik *et al*. (2015). Maximum productive tiller number m^{-2} and panicle length may be attributed to zinc's useful role in the biosynthesis of indole acetic acid (IAA), the beginning of the primordial reproductive parts, the partitioning of photosynthates, and increased tiller production.

Boron is responsible for better seed setting and has demonstrated a significant effect on the number of filled grains, which may account for the increase in the number of filled grains panicles^{-1}. Because of increased anther development, pollen germination, and pollen lowering, B decreases panicle sterility and increases fertility in rice, increasing panicle^{-1} and yield. These are consistent with those previously published by Ali *et al*. (2018), Yadav *et al*. (2005), and Rani and Latha (2017). Furthermore, the application of silicon, which aids in the uptake of other vital nutrients and is crucial for plant metabolic activity, may have contributed to the increase in panicle length and grain weight per panicle. Prakash *et al*. (2013) noted results that were similar to these.

The data regarding grain and straw yield was presented in table 1. The highest grain yield of 5641 kg ha^{-1} was recorded with the treatment 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% + Silicon @ 1% (T_8). With a grain yield of 5281 kg ha^{-1}, which is statistically comparable to 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% (T_5), this was followed by 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Silicon @ 1% (T_7). In rice, the 100% RDF treatment (T_1) showed a lower grain yield of 4015 kg ha^{-1}. This could be as a result of the NPK fertilizer's significant influence, which can enhance crop photosynthesis and raise the production of carbohydrates. A higher rice yield can be achieved by properly applying NPK nutrients, which can aid in the translocation and storage of carbohydrates. Paiman *et al*. (2021) reported similar outcomes. This could be explained by the above treatment combination's cumulative and synergistic effects, which maintain optimal nutro physiological conditions throughout the crop's growth. More leaf area, DMP, the number of productive tillers m^{-2}, and the number of filled grains panicles^{-1} are also results of improved nutrient uptake and effective assimilation of applied nutrients. The role of silicon in photosynthetic activity, increased enzyme activity, and carbohydrate translocation; zinc in increasing chlorophyll content; and boron in sugar transport, flower production, retention, and pollen tube elongation could all contribute to the increase in grain yield. This aligns with the research results of Deeksha *et al*. (2022) and Abinaya *et al*. (2021), which may have led to better yield attributes. Additionally, an adequate supply of silicon, boron, and zinc may have positively impacted the supply of other nutrients and stimulated the overall growth attributes of plants, contributing to the increase in the number of productive tiller m^{-2}. Similar outcomes were noted by Talib and colleagues (2016).

The treatment with the highest straw yield (T_8), 7632 kg^{-1} was 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% + Silicon @ 1%. Straw yield of 7306 kg ha^{-1} was recorded by the next best treatment (T_7), which was 100% RDF + foliar application of ZnSO4 @ 0.5% + Silicon @ 1%. This treatment is statistically comparable to 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25% (T_5). In 100% RDF (T_1), the lowest straw yield was noted. The greatest straw yield may have resulted from increased biomass production during the early phases of crop growth due to better nutrient utilization, which raised LAI and subsequently increased photosynthetic rate. The current findings concur with those of Awan *et al*. (2022) and Khattak *et al*. (2015).

The control (T_1) showed the lowest yield of grain and straw of all the treatments. This could be because foliar nutrient application is not being done, which shows in the soil's extremely low capacity to support growth and yield characteristics. Qureshi *et al*. (2018) reported similar outcomes of unfortified plots with lower productive parameters in rice.

CONCLUSION

Among the various treatments examined, the application of 100% RDF + foliar applications of $ZnSO_4$ at 0.5% + Borax at 0.25% + Silicon at 1% (T_8) greatly increased the yields of grain and straw, reaching a maximum of 5641 kg ha^{-1} and 7632 kg ha^{-1}, respectively. Application of 100% RDF + foliar application of $ZnSO_4$ @ 0.5% + Borax @ 0.25 % + Silicon @ 1% significantly influenced the yield attributes, *i.e*., number of panicles m^{-2}, panicle length, and number of filled grains $panicle^{-1}$ (T_8). Because test weight is genetic in nature, there was no discernible difference in test weight between the treatments. Under treatment T_1 (control), the lowest yield attributes and yield were observed.

TABLE 1. Effect of foliar application of nutrients on the number of panicles m^{-2}, Panicle length (cm), Number of filled grains $panicle^{-1}$, grain and straw yield of rice

Treatments	Number of panicle m^{-2}	Panicle length (cm)	Number of filled grains $panicle^{-1}$	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})
T_1 - 100 % RDF	263	19.20	73.75	4015	6100
T_2 - 100 % RDF + foliar application of $ZnSO_4$ @ 0.5%.	290	22.10	83.11	4952	6804
T_3 - 100 % RDF + foliar application of Borax @ 0.25%	276	20.40	78.93	4419	6419
T_4 - 100 % RDF + foliar application of Silicon @ 1%.	280	20.80	79.87	4607	6470
T_5 - 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% +Borax @ 0.25%	305	23.60	87.12	5281	7209
T_6 - 100 % RDF + foliar application of Borax @ 0.25% +Silicon @ 1%	294	22.60	83.86	4994	6855
T_7 - 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% +Silicon @ 1%	310	24.20	87.52	5355	7306

T_8 - 100 % RDF + foliar application of $ZnSO_4$ @ 0.5% +Borax @ 0.25% + Silicon @ 1%	325	26.10	90.89	5641	7632
S. Ed±	4.63	0.38	1.51	128	150
CD (P=0.05)	9.82	0.82	3.21	272	318

REFERENCES

[1] Saikh, M. A., A. K. Singh and S. K. Singh. 2022. Effect of foliar application of zincon growth and yield attributes of rice. **Journal of Pharmacognosy and Phytochemistry, 11(6):** 145-148.

[2] Siddika, M., M. J. A. Mian, T. S. Hoque, M. A. Hanif and P. C. Ray. 2016. Effect of different micronutrients on growth and yield of rice. **International Journal of Plantand Soil Science, 12(6):** 1-8.

[3] Soltani, S. M., S. Gholamalizadeh and R. Khaliqi. 2022. Rice growth improvement,bio fortification, and mitigation of macronutrient requirements through foliar application of zinc and iron- glycine chelate and zinc sulfate**. Journal of Plant Physiology and Biochemistry, 176:** 87-97.

[4] Songsriin, J., Y. amuangmorn, S. Lordkaew, S. Jumrus, J. Veeradittakit, S. Jamjod and C. Promuthai. 2023. Efficacy of soil and foliar boron fertilizer on boron uptake and productivity in rice. **Agronomy, 13(3):** 692-699.

[5] Singh, V., V. Singh and S. Singh. 2020. Effect of zinc and silicon on growth andyield of aromatic rice (*Oryza Sativa*) in north-western plains of India. **Journal of Rice Research and Development, 3(1):** 82-86.

[6] USDA-United States Department of Agriculture, Global Market Analysis- 2022.

[7] Singh, P. K., V. Bhardwaj and S. K. Sharma. 2005. Nutrient requirement for optimum yield of hybrid rice in mollisols. **Annals of Agricultural Research New Series, 726(4):** 561-567**.**

[8] Hartatik, W., L. R. Widowati and A. Islam. 2015. Effect of compound fertilizer NPKS andNPK on rice growth and yield on Inceptisol. **Penelitian Pertanian TanamanPangan, 34(3):** 175-186.

[9] Yadav, M. P., M. Aslam, and S. P. Kushwaha. 2005. Effect of integrated nutrientmanagement on rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping systemin Central Plains Zone of Uttar Pradesh. **Indian Journal of Agronomy, 50(2):** 89- 93.

[10] Rani, P. S and A. Latha. 2017. Effect of calcium, magnesium and boron on nutrient uptake and yield of rice in Kole lands of Kerala. **Indian Journal of Agricultural Research, 51(4):** 388-391.

[11] Ali, M. I., M. A. R. Sarkar and S. K. Paul. 2018. Influence of plant nutrient management on the yield performance of transplant Aman rice (*Oryza sativa* L.). **Archives of Agriculture and Environmental Science, 3(1):** 49-53.

[12] Prakash, M. B., M. S. Reddy, E. Aruna and P. Kavitha. 2013. Effect of N and P levelson growth parameters, yield parameters, yield, nutrient uptake and economics of rice(*Oryza sativa)*. **Crop Research, 45(1-3):** 33-38.

[13] Paiman, P. A., U. P. Y. Fakultas Pertanian, A. Ardiyanta and C. T. Kusumastuti. 2021. Maximizing the rice yield (*Oryza sativa* L.) using NPK fertilizer. **The Open Agriculture Journal, 15:** 33-38.

[14] Abinaya, M., R. Manivannan, M. V. Sriramachandrasekharan, P. Senthilvalavan, S. Kalaisudarson and C. Ravikumar. 2021. Response of rice (*Oryza sativa* L.) productivity and nutrient uptake to nitrogen and boron fertilization in typic ustifluvents soil. **Journal of Applied and Natural Science, 13(4):** 1372-1377.

[15] Deeksha, A., V. Kumar and N. S. Sachan. 2022. Role of micronutrients in crop production and their management for sustainable agriculture: A review. **Journal of Pharmacognosy and Phytochemistry, 11(6):** 289-304.

[16] Talib, S., M. A. Bhat, A. Hussain, M. A. Ganai and N. A. Teli. 2016. Effect of levels and sources of zinc on growth, yield and economics of rice (*Oryza sativa*) under temperate conditions. **Indian Journal of Agronomy, 61(2):** 186-190.

[17] Khattak, S. S., M. Arif, T. Hussain and S. Ahmad. 2015. Role of foliar application of zincsulfate in improving growth and yield of rice grown under different nitrogen levels. **Biologia plantarum, 59(2):** 329-338.

[18] Awan, T. H., P. C. Stacruz, M. Farooq and B. S. Chauhan. 2022. Influence of seeding rate,nitrogen rate and weed regimes on productivity and nitrogen efficiency of dry direct-seeded rice. **International Journal of Plant Production,** 1-18.

[19] Qureshi, A., D. K. Singh and A. Kumar. 2018. Climate Smart Nutrient Management (CSNM) for enhanced use efficiency and productivity in rice and wheat under rice-wheat cropping system. **International Journal of Current Microbiology andApplied Sciences, 7:** 4166-4176.