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# Effect of chelated micronutrients on the yield attributes and yield of rice

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**Abstract**
Iron and Zinc were the yield limiting factor found to be deficit in the soils of Kallikudi block of Madurai district, Tamil Nadu. Therefore a field experiment was conducted to evaluate the effect of yield attributes and yield of rice under various doses of chelated micronutrients at the farmer's field during Nov 2018-Jan 2019 in a randomized block design with five replications. Fourteen treatments were imposed and the results revealed that the application of chelated micronutrient mixture (Zn lysinate + Fe methionate) @ 12.5 kg ha$^{-1}$ ($T_{13}$) along with recommended dose of fertilizers (RDF) increased the yield attributes viz., number of productive tillers (14.6), number of filled grains per panicle (228), thousand grain weight (12.99 g), grain yield (6595 kg/ha) and straw yield (8845 kg/ha).

**Keywords:** Zinc, Iron, Fe methionate, Zn lysinate, Grain yield

## Introduction
Rice (*Oryza sativa* L.) is cultivated world-wide over an area about 156.68 m ha with an annual production of about 650.19 million tons (Anonymous, 2013) [2]. India stands at second position in production of rice in the world. During 2016-17, the total area under rice in India is 44 mha with a production of 105 mt. Among the Indian states, Tamil Nadu is the one of the leading rice growing states which contributes 8 per cent of national rice production with 5.34 mt from an area of 1.97 mha, with an average productivity of 3.19 t ha$^{-1}$.

Producing micronutrient enriched cereals via biofortification, either agronomically or genetically, and improving Fe and Zn bioavailability are considered promising and cost effective approaches for diminishing malnutrition (Distelfeld *et al*., 2007) [6]. Metal ions such as iron, zinc, copper, manganese and magnesium as a cofactor participate in construction of many antioxidant enzymes and results of Cakmak *et al.* (2010) [5]. Zinc and Fe are involved in detoxification of reactive oxygen specious (ROS) and they are also important for reducing the production of free radicals by superoxide radical producing enzymes.

Zinc is main limited micronutrient of flooded rice, about 80-90 % of soil applied zinc is unavailable to plant due to its various harmful reactions with various soil components like organic matter, clay sesquioxide etc. So chelated form of zinc may be an alternative source of Zn in crop production (Basal and Nayyar 1989; Karak *et al*., 2002) [3, 9].

Sodic, upland and calcareous coarse-textured soils with low organic matter content suffer from Fe deficiency. Organic sources have improved the content of Fe by supplying chelating agents, which helps in maintaining the solubility of micro-nutrients including Fe. The response of chelating agents showed profound influence on the solubility of Fe in waterlogged soil by providing resistance to Fe chlorosis.

EDTA being a carcinogenic agent, the use of amino acid chelated metals may be a right choice for correcting deficiencies and availability of particular metals. In India Zn deficiency and Fe availability is the most widespread problem under the area of high yielding crop varieties particularly in low land rice. Therefore it was worthwhile to study the effect of chelated Fe and Zn on yield attributes and yield of rice.

## Materials and Methods
The present investigation was conducted as field experiment during Nov 2018 – Jan 2019 at Lalapuram village, kallikudi block of Madurai district with the rice cultivar TKM 13 as a test crop which is a semi dwarf, with 135 days maturity. The experiment was laid out with 14

treatments and replicated five times. The size of the experimental plot was 5 x 4 m and 0.5 cm wide of irrigation channels were placed between the replications to ensure uninterrupted flow of irrigation water and 21 days old rice seedlings were transplanted per hill at a spacing of 25 x 25 cm.

Physico-chemical properties of the soil were measured by the standard methods of soil chemical analysis. The analysis of experimentation revealed that the soil is neutral in reaction, Non – Saline, low organic carbon (0.45), low available nitrogen (193.2 kg/ha), medium available phosphorus (20 kg/ha), medium available potassium (156 kg/ha), low DTPA Fe and Zn with 2.88 ppm and 1.28 ppm respectively. The treatmental details were Control with no RDF ($T_1$), RDF @ 150:50:50 kg ha$^{-1}$ ($T_2$), RDF + $ZnSO_4$ @ 25 kg ha$^{-1}$ ($T_3$) , RDF + $FeSO_4$ @ 50 kg ha$^{-1}$ ($T_4$), RDF + Chelated Zn @ 2.5 kg ha$^{-1}$ ($T_5$), RDF + Chelated Zn @ 3.75 kg ha$^{-1}$ ($T_6$), RDF + Chelated Zn @ 5 kg ha$^{-1}$ ($T_7$) , RDF + Chelated Fe @ 5 kg ha$^{-1}$ ($T_8$) , RDF + Chelated Fe @ 7.5 kg ha$^{-1}$ ($T_9$) , RDF + Chelated Fe @ 10 kg ha$^{-1}$ ($T_{10}$) , Chelated micronutrient mixture @ 7.5 kg ha$^{-1}$ ($T_{11}$), Chelated micronutrient mixture @ 10 kg ha$^{-1}$ ($T_{12}$) , Chelated micronutrient mixture @ 12.5 kg ha$^{-1}$ ($T_{13}$), TNAU micronutrient mixture @ 12.5 kg ha$^{-1}$ ($T_{14}$).

As per the treatment schedule, nitrogen, phosphorus and potassium fertilizers were applied at the rates of 150, 50 and 50 kg ha$^{-1}$ in the form of urea, super phosphate and muriate of potash, respectively. The entire dose of P was applied basally and N and K were applied in four equal splits *viz.,* 1/4 as basal, 1/4 at active tillering stage and 1/4 at panicle initiation stage and 1/4 at heading stage of the crop. Zinc sulphate @ 25 kg ha$^{-1}$ ($T_3$) and Ferrous sulphate @ $FeSO_4$ @ 50 kg ha$^{-1}$ ($T_4$) were mixed with sand for uniform distribution, were applied in each plots. The Zn lysinate @ 2.5, 3.75 & 5 kg ha$^{-1}$, Fe methionate @ 5, 7.5 & 10 kg ha$^{-1}$, chelated micronutrient mixture (Zn lysinate + Fe methionate) @ 7.5, 10 & 12.5 kg ha$^{-1}$ and TNAU micronutrient mixture @ 12.5 kg ha$^{-1}$ were mixed with sand (25 kg), then the mixture was broadcasted uniformly as per the schedule ($T_5$ to $T_{14}$)**.**

Observations on yield and yield attributes like number of productive tillers per hill, number of filled grains per panicle, 1000 grain weight were recorded. All replicated data were analyzed statistically using AGRES software.

## Results and Discussion

### Yield attributes of rice at harvest

At harvest, yield components such as number of productive tillers hill$^{-1}$, number of filled grains per panicle and 1000 grain weight were significantly influenced by the application of chelated micronutrient mixture. The highest number of productive tillers hill$^{-1}$ (14.6) and the number of filled grains per panicle (217) were registered with the treatment received with RDF + chelated micronutrient mixture at 12.5 kg ha$^{-1}$ which was followed by the treatment RDF + chelated micronutrient mixture @ 10.5 kg ha$^{-1}$ (14.4 numbers of productive tillers hill$^{-1}$ & 213 numbers of filled grains panicle$^{-1}$). The lowest number of productive tillers hill$^{-1}$ (7.4) and number of filled grains panicle$^{-1}$ (157) were recorded by the absolute control. The 1000 grain weight remained statistically unaffected by the study but the higher test weight was recorded by the $T_{13}$ and lowest being the $T_1$. Increased values in the yield attributes might have been on account of the overall improvement in vegetative growth which favorably influenced flowering and ultimately resulted in increased number of productive tillers hill$^{-1}$, as well as number of filled grains panicle$^{-1}$.

These findings have similarity with the result of Habib (2012) [7] who obtained significant increase in 1000-kernels weight when Zn and Zn+Fe chelates supplied on foliage at grain filling period of wheat in comparison with Fe supplement without affecting grain numbers per spike. Zinc as a synthesizer of protein and carbohydrate resulted into bolder seeds compared to control resulting into more test weight (Ram *et al*., 2014) [11].

### Grain and Straw yields of Rice

The grain yield of rice was significantly influenced due to different treatments and it ranged from 2312 to 6334 kg/ha where the lowest and the highest grain yields were obtained in the $T_1$ (Control) and $T_{13}$ (chelated micronutrient mixture @ 12.5 kg/ha) respectively. On the other hand, straw yield of rice ranged from 3468 to 8648 kg/ha where it was observed that the treatment ($T_{13}$) chelated micronutrient mixture @ 12.5 kg ha$^{-1}$ produced the highest straw yield and the lowest straw yield obtained in $T_1$. Higher values of yield attributing characters resulted in higher values of grain yield. Zeiden *et al*. (2010) recorded significant increase in all grain yield parameters and straw yield when Zn and Fe were sprayed on foliage at tillering and booting stage in wheat plant.

The favorable influence of applied Zn on yield may be due to its catalytic or stimulatory effect on most of the physiological and metabolic process of plants whereas iron helps in utilization of nitrogen and are actively involved in photosynthesis and mitochondrial respiration. All these physiological processes proved instrumental in increasing yield by application of both these micronutrients as a soil application.

## Conclusion

Based on the results of this experiment, it is concluded that the application of iron and zinc fertilizers either as salts or chelated form as a soil application in single or in mixture in rice contributed marked increase in plant yield attributes, grain yield and straw yield compared to other treatments because of availability of micronutrients. Application of micronutrients in association with NPK showed better performance as micronutrients have immense economic importance since an adequate supply of micronutrients can help to ensure better yields. Therefore the application of chelated micronutrient mixture @ 12.5 kg/ha along with RDF (150:50:50) could be the promising combination for maximizing rice yield.

**Table 1:** Effect of chelated micronutrient mixture on Yield attributes of rice (Mean of five replications)

| Treatments | No. of productive tillers hill$^{-1}$ | No. of filled grains panicle$^{-1}$ | 1000 grain weight (g) |
|---|---|---|---|
| $T_1$ | 7.4 | 157 | 12.81 |
| $T_2$ | 13.2 | 192 | 12.92 |
| $T_3$ | 13.2 | 194 | 12.91 |
| $T_4$ | 13.3 | 196 | 12.93 |
| $T_5$ | 13.4 | 198 | 12.93 |
| $T_6$ | 13.6 | 201 | 12.94 |
| $T_7$ | 13.8 | 203 | 12.95 |
| $T_8$ | 13.7 | 202 | 12.95 |
| $T_9$ | 13.9 | 205 | 12.96 |
| $T_{10}$ | 14.0 | 209 | 12.97 |
| $T_{11}$ | 14.1 | 210 | 12.97 |
| $T_{12}$ | 14.4 | 213 | 12.98 |
| $T_{13}$ | 14.6 | 217 | 12.99 |
| $T_{14}$ | 14.3 | 213 | 12.98 |
| SEd | 0.09 | 1.69 | 0.32 |
| CD(P=0.05) | 0.19 | 3.48 | 0.67 |

**Table 2:** Effect of chelated micronutrient mixture on Grain and straw yield (kg ha$^{-1}$) of rice (Mean of five replications)

| Treatments | Yield (kg ha$^{-1}$) | | | |
|---|---|---|---|---|
| | Grain | Per cent increase over RDF alone | Straw | Per cent increase over RDF alone |
| $T_1$ | 2312 | - | 3468 | - |
| $T_2$ | 5018 | - | 7672 | - |
| $T_3$ | 5224 | 4.1 | 7731 | 0.8 |
| $T_4$ | 5241 | 4.5 | 7753 | 1.1 |
| $T_5$ | 5217 | 4.0 | 7825 | 2.0 |
| $T_6$ | 5371 | 7.0 | 7932 | 3.4 |
| $T_7$ | 5579 | 11.2 | 8271 | 7.8 |
| $T_8$ | 5421 | 8.0 | 8130 | 6.0 |
| $T_9$ | 5629 | 12.2 | 8302 | 8.2 |
| $T_{10}$ | 5871 | 17.0 | 8474 | 10.5 |
| $T_{11}$ | 5885 | 17.3 | 8493 | 10.7 |
| $T_{12}$ | 6112 | 21.8 | 8660 | 12.9 |
| $T_{13}$ | 6334 | 26.2 | 8806 | 14.8 |
| $T_{14}$ | 6084 | 21.2 | 8648 | 12.7 |
| SEd | 84.60 | - | 64.39 | - |
| CD(P=0.05) | 173.91 | - | 132.37 | - |

## References


1. Alvarez-Fernandez A., Garate A., Juarez M, Lucena, JJ. Tomato acquisition of iron from chelates in calcareous sandy substrate. Journal of Plant Nutrition. 1996; 19:1279-1293.
2. Anonymous. Agriculture Research Data Book, Ministry of Agric., Govt. of India, 1996.
3. Basal RL, Nayyar VK. IRRI News letter. 1989; 14:24.
4. Baybordy A, Mamedov G. Evaluation of Application methods efficiency of zinc and iron for canola (*Brassica napus* L.). Natulae Scientia Biologicae. 2010; 2(1):94-103
5. Cakmak I, Pfeiffer WH, McClafferty B. Biofortification of durum wheat with zinc and iron. Cereal chem. 2010; 87:10-20
6. Distelfeld A, Cakmak I, Peleg Z, Ozturk L, Yazici MA, Budak H, Saranga Y, Fahima T. Multiple QTL-effects of wheat Gpc-B1 locus on grain protein and micronutrient concentrations. Physiol Plant. 2007; 129:635-643.
7. Habib M. Effect of supplementary nutrition with Fe, Zn chelates and urea on wheat quality and quantity. Afr. J Biotechnol. 2012; 11(11):2661-2665.
8. Kadam SR, Bhale VM, Chorey AB, Deshmukh MR. Influence of zinc and iron fortification on yield and post-harvest studies of different rice cultivars (Oryza sativa L.). Int. J Curr. Microbiol. App. Sci. 2018; 7(1):1878-1888.
9. Karak OT, Das DK, Karmakar SK. In proc. 17th World congress of Soil Science, held on 14-21 August 2002 at Bangkok Thailand. 2002; Paper no. 64.
10. Naik SK, Das DK. Relative performance of chelated zinc and zinc sulphate for lowland rice (*Oryza sativa* L.) Nutrcycle Agrocwsyst. 2008; 21:219-227
11. Ram B, Singh SK, Latare AM, Kumar O. Effect of sulphur, zinc and boron application on growth and yield of hybrid rice (*Oryza sativa*). Journal of Indian Society of Soil Science. 2014; 62(2):184-188.
12. Zeidan MS, Manal FM, Hamouda HA. Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility. World J Agric. Sci. 2010; 6(6):696-699.